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PRACTICAL DYNAMO CALCULATION.

In the present issue we print a second section of a series of "Practical Notes on Dynamo Calculation," by Mr. A. E. Wiener, in which will be developed a complete practical treatise on dynamo calculation intended for actual use and not as a theoretical contribution to the subject. The treatment is based upon results obtained in practice, and will include numerous original tables derived from the data and tests of almost two hundred modern dynamos of all types and of both European and American make. The articles are written in a simple style and will be devoid of the mathematical abstractions which so frequently accompany writings on similar subjects and destroy their value to those to whom they should prove most useful. They will form a notable departure from time honored electrical practice in this respect and more nearly follow the methods used by writers in the older branches of engineering. While primarily intended for the designer and the student of electrical engineering, every one interested in electrical pursuits will find the vast fund of practical information of interest, not only directly, but as furnishing concrete illustrations of the principles concerned both in the theory and operation of dynamos.

HONORS TO FRENCH ELECTRICIANS.

The current number of the "Bulletin de la Societe Internationale des Electriciens" announces that the President of the French Republic has conferred merited rewards upon a number of French electricians for their services in connection with the Chicago World's Fair. MM. Barbier, Carpentier, Lippmann and Violle have been promoted to the grade of officer in the Legion of Honor and MM. De La Touanne, Milde, Picou and Richard awarded its decoration of Chevalier. Most of these names, particularly Lippmann, Violle, Picou, Richard and Carpentier, are doubtless familiar to our readers, but the absence will probably be noted of those of two Frenchmen eminent in electrical science who honored the Chicago Electrical Congress with their presence, and whose writings are almost as well known in America as in France—Mascart and Hospitalier. Of these, Mascart has already reached the highest place on this distinguished roll, his splendid abilities having long since exhausted the official honors which France delights to lavish on her great savants. Without presuming to criticise the omission of the name of Hospitalier, perhaps the best known in America of all the eminent Continental electricians through the wide circulation secured for his works by their distinctively practical character, yet the gratitude which American electricians feel for his generous services in behalf of the henry, both in France and at Chicago, will give rise to a regret that he has not received a recognition which would also have been considered a compliment to the cause in which he labored.

INDUCTANCE AND REACTANCE.

The Institute, at its annual meeting last week, took another important and creditable step in the direction of the good work which it started nearly two years ago when it made the important suggestions to the recent International Congress, most of which, though meeting with no action there, have nevertheless borne good fruit. As the comparatively new term "inductance" was being used with two entirely different meanings, the Institute, at the suggestion of its Committee of Units and Standards, has now decided that,

at least in this country, as far as the great weight of its authority extends, the term is to be used only in the sense of a coefficient of induction, the cumbersome expressions "coefficient of self-induction" and "coefficient of mutual induction" to be consequently replaced by "self-inductance" and "mutual inductance." As the other quantity for which this term was sometimes used was thereby left nameless, the term "reactance," upon the motion of Mr. Steinmetz, was adopted for it, the reactance being the spurious or wattless component of the resistance, which, when properly combined with the true ohmic resistance, gives the impedance. The definitions of these two quantities as adopted by the Institute will be found in another column, and we urge all Americans to aid the Institute in this good work by adopting these terms in their writings. The English will undoubtedly join us, at least in adopting the term "inductance" in this sense, as it originated in their own country with that meaning. It is quite likely, too, that the Germans will at least not use these terms in any other sense and they may even adopt them. The French, we fear, will not be as easily persuaded, as their leading society has already expressed itself as being satisfied with the present terms. It may be added, however, that the adoption of the term "reactance" has been strongly advocated by no less an authority than M. Hospitalier. The usual objections to the introduction of new names will doubtless be raised by some, especially by those who do not understand these terms and quantities, or who do not appreciate the advantages of uniformity and simplicity in our international electrical language. Such persons may continue to use the older and longer expressions for inductance and replace the simple term reactance by its cumbersome definition every time they refer to this important quantity; the loss is their own.

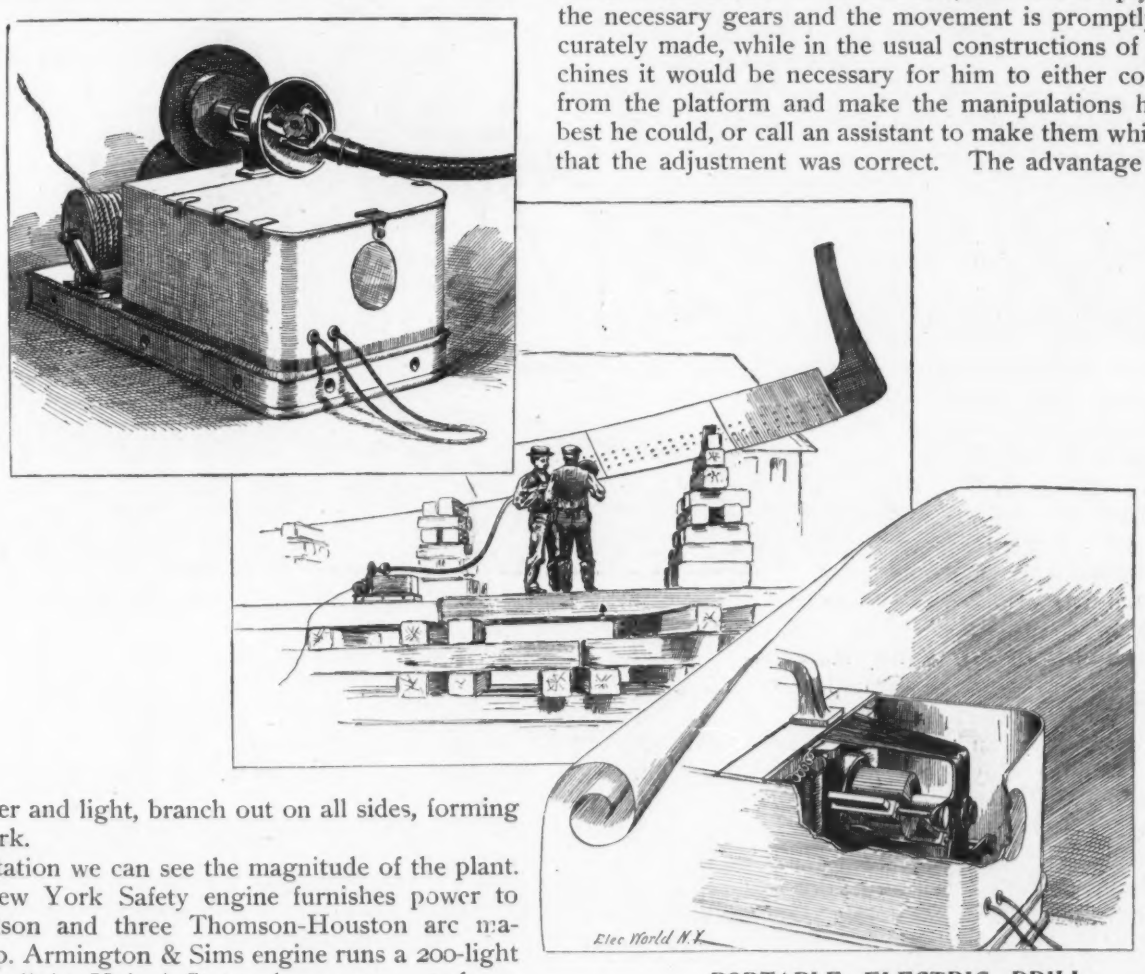
ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The growing vigor of the American Institute of Electrical Engineers and the professional influence which it exercises were most gratifyingly manifested at the recent annual meeting at Philadelphia, which was pronounced by all to be the most successful in its history. Not only was the attendance the largest—in numbers but little short of 150—but the interest in its proceedings was the most sustained as shown by the manner in which the attendance kept up. The assembly room of the Engineers' Club, though having a seating capacity of about 100, was so well filled that few vacant chairs were seen at any time, while at several of the sessions the room proved entirely too small, many members being unable to obtain admittance. A praiseworthy recognition of the national character of the body was shown by the spirit in which a measure affecting the Chicago meeting was received. The success of the first local meeting, it may be added, was a frequent subject of remark among the members present, and our Chicago brethren would have felt gratified at hearing the pleasure expressed on all sides at the success of their efforts. The social features of the meeting were not less successful than the professional ones, and all of those in attendance doubtless carried away a feeling that not only in name but in deeds the Quaker City is truly the "City of Brotherly Love." The annual dinner proved a most agreeable relaxation. We doubt if any other professional body in the country is as fortunate in the possession of graceful speakers at its social gatherings, for besides those who did honor to this occasion, the list of those present who possessed the envied gift of post-prandial oratory was far from being exhausted. The address of President Houston at the opening of the general meeting, besides its appropriateness for the occasion of the meeting of the Institute at its birthplace, is a valuable addition to the Transactions, covering as it does the interesting period of the childhood and youth of the Institute; for that body can now be considered to have passed to a stage when its future is secure, and henceforth its deeds will furnish their own record. The programme of papers was an unusually satisfactory one, covering a wide range in which the highest theory and the most practical applications were equally represented. Of the fourteen papers read, the most notable were perhaps those of Messrs. Pupin, Steinmetz, Duncan, Crocker and Crehore. The paper of Dr. Pupin in a sense is an extension and application of the principles developed in his paper read before the annual meeting of last year, and relates directly to the analysis of alternating current curves by means of the resonance principle, and investigations into the origin of harmonics. An interesting result of the method outlined was the proof it furnished of the constant intensity of a rotary magnetic field, which has so often been doubted. In the paper of Mr. Steinmetz, which is a continuation of his classical researches in hysteresis, it was shown that the results of investigations by others have confirmed those arrived at by him as contained in the previous sections of the same paper. Among the points of interest in the paper are a discussion of the distinction between hysteresis and molecular magnetic friction, and data showing that much better iron can now be commercially obtained from a hysteretic standpoint than existed but a few years ago. The paper by Dr. Duncan contains a description of another application of his elegant method of alternating current analysis, this time to induction motors, including the study of their armature currents. Dr. Crehore described a beautiful method devised by him for the study of magnetic induction, based upon the change in the coefficient of refraction of a material in a field of induction. By this method, unlike others, there is no inertia to mar the results, and a ray of light is employed as a pointer in the apparatus described. Relating to new apparatus are the papers of Messrs. Willyoung, Wurts and Bedell. The commercial character which sometimes attaches to papers of this kind is in the present case relieved by the very full manner in which the principles concerned are illustrated, while the very complete experimental demonstration by Mr. Wurts of the physical facts relating to his subject was one of the successful features of the meeting. The phase indicator of Dr. Bedell, while apparently possible of only a limited application, is, nevertheless, a device as ingenious as it is simple. The paper of Mr. Griscom is particularly appropriate at the present time in view of the renewed interest being taken in storage batteries, and will doubtless result in some of the many points considered being taken up by others. An unusual amount of information and data is furnished in regard to obscure points in the theory of the storage battery, and the several problems left open for solution have their bearings most clearly indicated. The paper of Prof. Anthony is useful as bringing out the principles that should not be lost sight of in the consideration of the distribution of light, but perhaps it would have been well to have laid more stress upon the fact that owing to other important factors that enter into the case the one developed should rather be considered a guide than as capable of direct application. Messrs. Jackson and Ochsner by their experiments cast doubt upon the generally accepted principle that fuses are deteriorated by alternating currents, yet we should await further confirmation of their results before casting aside those of previous experimenters, with which they conflict. Dr. Bell brings forth some more hard facts in favor of induction motors, and shows that the power factor varies little within a very considerable practical range, while the reproach of the inefficiency of such motors at other than normal load applies with no greater force than to direct current series motors, which have no advantage whatever in this respect. The papers of Messrs. Adams and Owens deal with important points in dynamo design, and added to their intrinsic value by developing what was perhaps the most valuable discussion of the meeting.

Electricity at Cramps' Ship Yard.

EVERY one is familiar with the name of the William Cramp & Sons Ship and Engine Building Company, of Philadelphia, but the important part which electricity in its yard plays in the construction and equipment of a modern vessel is not so well known.

Electricity was first introduced into this yard in 189c, and from a small plant of two incandescent machines and about one hundred lamps it has grown to an immense extent in the past four years, until now over 3,000 incandescent lamps and 125 arc lamps are in use. Recognizing the many advantages which the electric motor possesses, the general adaptability to every condition where power is required has led to the introduction of electricity where it was possible. Situated almost in the centre of the large yard is the electric light station, or, as it is commonly called, power house, and from its lofty cupola the numerous wires, for the transmission of power and light, branch out on all sides, forming a perfect network.



PORTABLE ELECTRIC DRILL.

Within the station we can see the magnitude of the plant. A 200-h. p. New York Safety engine furnishes power to drive four Edison and three Thomson-Houston arc machines; a 50-h. p. Armington & Sims engine runs a 200-light Edison and 300-light United States dynamo; a 150-h. p. vertical compound engine runs the 400-light Electro-Dynamic Company's dynamo and the 110-kw. Eddy generator for power transmission around the yard.

Electricity is of much value in the large boiler shop, where there are two 50-ton and one 10-ton electric cranes, which do all the hoisting and transporting of the immense boilers for the ships, some weighing eighty tons and over, which, nevertheless, are handled with the utmost ease. Here we see that the electric motors possess advantages over any other form of power which could be used.

A useful tool in this shop is a machine for drilling and tapping marine boiler heads, made by Wm. Sellers & Co., and employing H. Ward Leonard's system of electric control. It has a spindle 4 inches in diameter, with a vertical range of 8 feet, a horizontal range of 14 feet, and a stroke of 30 inches, and is driven by an electric motor carried upon the back of the upright, giving no less than 30 forward and 30 backward speeds. It also has a special feed for milling, and this feed is not dependent upon the spindle, is also entirely separate from the drilling and boring feeds, and yet has a range for the widest possible variation in diameter of milling cutter and pitch of cutting tooth. In short, it is suitable for all kinds of milling work. The drilling and boring feeds are in two series of fine and coarse, each with a wide range, and the total variation is from .002 to .3 of an inch. The centre of the spindle is only eight inches from the face of the upright, and the long bearing of the boring head insures a very stiff machine under cut. One very important feature of the whole arrangement is that the operator travels with the boring head, and he can therefore make any movement of the spindle, horizontally or vertically, at the head itself, promptly, at the rate of 20 feet per minute or less and with the greatest nicety. For instance, if the machine is at work at a height of, say, six feet from the floor, and it should be necessary to shift horizontally either a few inches or several feet, the man simply engages the necessary gears and the movement is promptly and accurately made, while in the usual constructions of such machines it would be necessary for him to either come down from the platform and make the manipulations himself as best he could, or call an assistant to make them while he saw that the adjustment was correct. The advantage of being able to make nice adjustments quickly, and thus keep the boring, drilling or milling tools under cut as much of the time as possible, is apparent, as well as the absence of the usual long shafts to transmit the power to the spindle and the great variety of speeds which is possible with the Leonard electric system of regulation.

Portable electric drills are used around the yard for drilling holes in the plates of the vessel, as illustrated in Fig. 1, which shows a 2-h. p. Electro-Dynamic Company's drill motor, with flexible shaft drilling holes in keel plates. These motors do all the heavy drilling through the thick protective deck sheets of the war vessels, saving much valuable time.

Passing from the boiler shop to the I. P. Morris foundry,

one of the best equipped in the country, it is surprising to see how much the foundry man depends upon electricity, yet not a single accident is recorded since the 50-ton electric crane was installed. This crane is one of the latest type built by William Sellers & Co., of Philadelphia, and is especially interesting from the fact that it is worked entirely by electric motors, every movement being controlled by a separate motor. Electricity is put to many other uses in the foundery; all the gib cranes are run by motors, and their speed can be varied as required by special resistance boxes close at hand. The centrifugal sand mixer receives its power from a 10-h. p. motor, as also the loam mill and sieve, and for lifting cores a small 10-ton crane performs the work. The 5-ton electric crane, which handles the plates in the ship shed and the brass foundry, with its 25-ton Shaw crane and numerous motors, completes the list of electric cranes now installed.

Perhaps the most useful electrical machine in the works is the electric hoist, consisting of a 30-h. p. Billberg motor directly connected by gearing to a Williamson hoisting engine, the motor of which is controlled by the White automatic switch. The switch is geared to the armature shaft, and consists of a rotating electric magnet separately excited and having a circular iron keeper attached to the switch lever, which, when the armature circuit is closed by throwing the hand switch, also closes the circuit on the electromagnets, causing the switch lever to rotate, which cuts out the sections of resistance successively, until the lever has reached the stop at the top switch circle; here the ring slides on the face of the magnet until the main circuit is broken, when the switch lever drops to the starting position by either weight or spring attachment. This useful machine has done all the hoisting of the steel plates on the International Navigation Company's new ship St. Paul, now in course of construction, requiring no repair and little attention since installed.

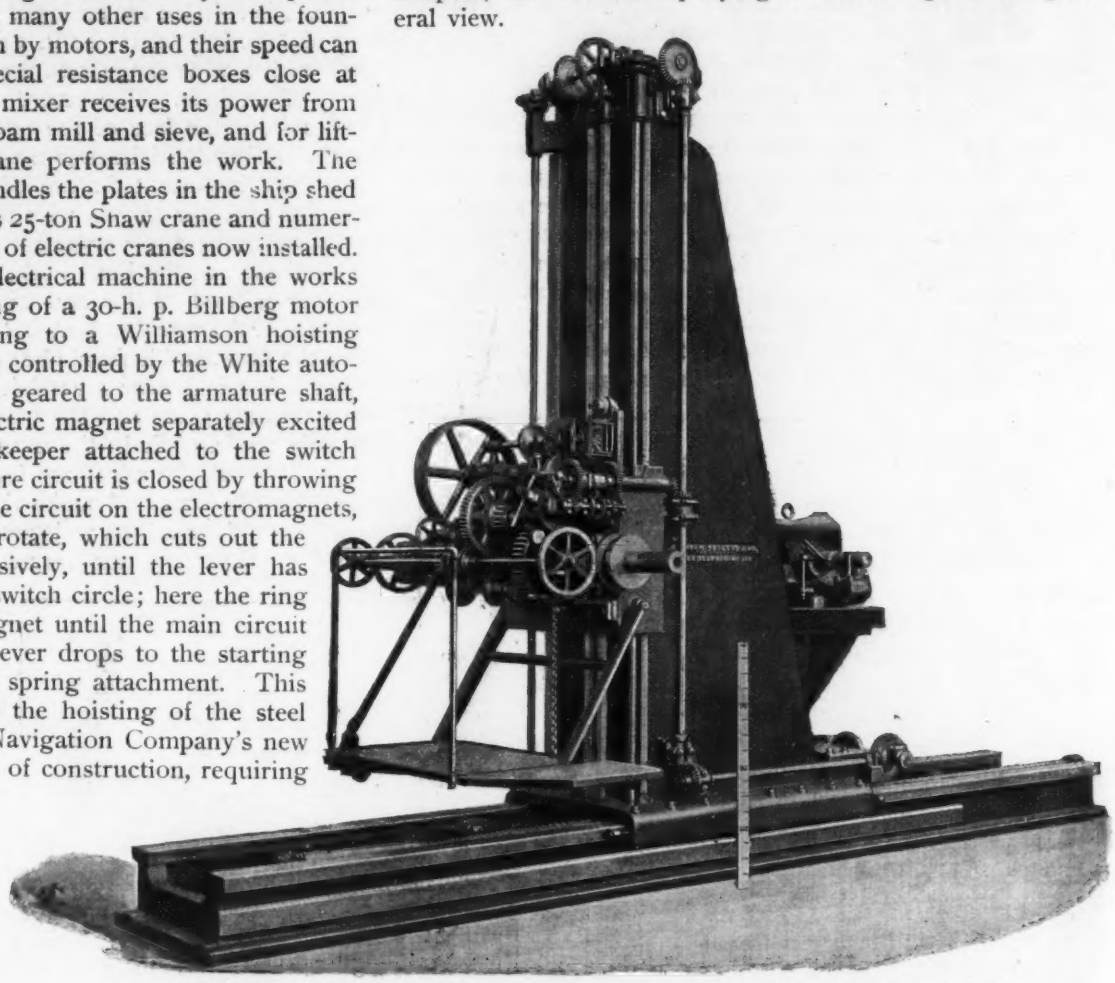
In the bending shed, the iron, white with heat, is drawn from the furnaces by aid of the 10-h. p. electric hoisting engine, a cut of which is given herewith, accomplishing in a few seconds the work of from forty to fifty laborers.

The incandescent light is an important thing, even a necessity in the construction of a ship. As soon as the plates are on the ship, and it becomes dark, it is necessary to light up the interior by some artificial light, and here the incandescent lamp has superseded the candle and the dangerous oil lamp for temporary lighting. In the ships under construction there are about 2,000 incandescent lamps, lighting them from stem to stern, and affording the workman plenty of light, even in the darkest corners, where candles would hardly be of any service.

Small motors furnish power for grindstones on the ships, while the portable electric drills are used for many purposes, saving time and labor.

The electric "deck planer," lately imported from England, planes with its sharp steel knives the rough decks, performing the work in one-quarter the time it would require to do it by hand and with greater accuracy. An electric elevator in the main office affords an easy means of communicating with the different floors; electric fans for cooling the offices, electric clocks, call bells and telephones sum up the many uses to which electricity is put within the works.

It is now well recognized what an important place electricity has in the equipment of a modern warship. In 1891 the electrical department was established in this yard, and since then the company has installed electric light plants in the following Government vessels: United States steamships New York, Columbia, Minneapolis, Indiana and Massachusetts. Since the plants in the above vessels have been subjected to a severe Government test and passed all requirements, it shows conclusively that the electrical details are as carefully looked after as any other important feature in the construction of the ship. In the Government plants a standard type of generating set has been adopted, and the accompanying illustration gives the general view.



BORING, DRILLING AND MILLING MACHINE, WITH ELECTRIC CONTROL.

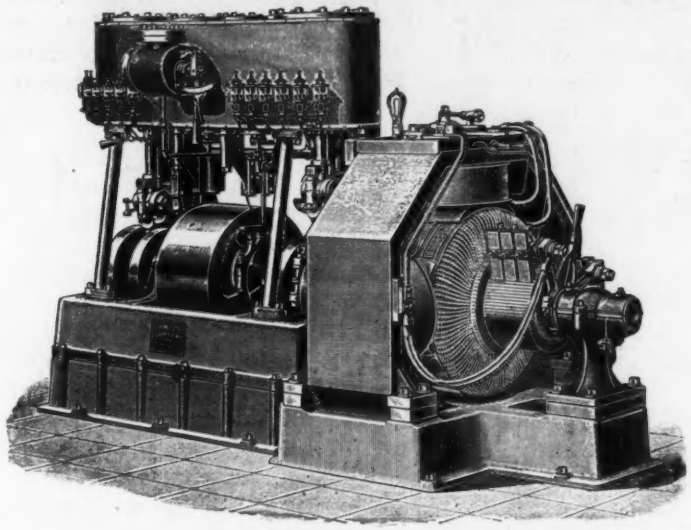
The engine shaft and armature shaft are directly coupled, the armature being secured with a feather and two set screws to the armature shaft. The engines are run without the use of lubricants in steam spaces, they are compact and light, and all parts are accessible for examination; they govern automatically, consequently the brushes on the dynamo are fixed for all loads. The dynamos are four-pole, compound wound, with a special resistance for series field directly on the headboard of the machine. The magnetic field is inappreciable at a distance of 15 feet. The engines make 400 revolutions with 80 pounds of steam.

The dynamo room is located below the protective deck and as near as possible to the boilers. For ventilating the dynamo room an electric motor directly connected to an exhauster fan is used. This fan draws air from the deck and discharges it through the outlets, so placed as to give the best circulation of fresh air within the room. In some ships a blower for taking out the foul air is installed. Small portable ventilating fans are used for ventilating the double bottoms and such places, taking their current from an ordinary lamp attachment.

The switchboard adopted by the United States Navy is shown in the accompanying illustration. It combines small size and weight and simplicity in control. A section can be changed from one dynamo to another by simply shifting the knife switch seen in the illustration and any combination of dynamos can also be made.

The two-wire system is the one used, and the wires are

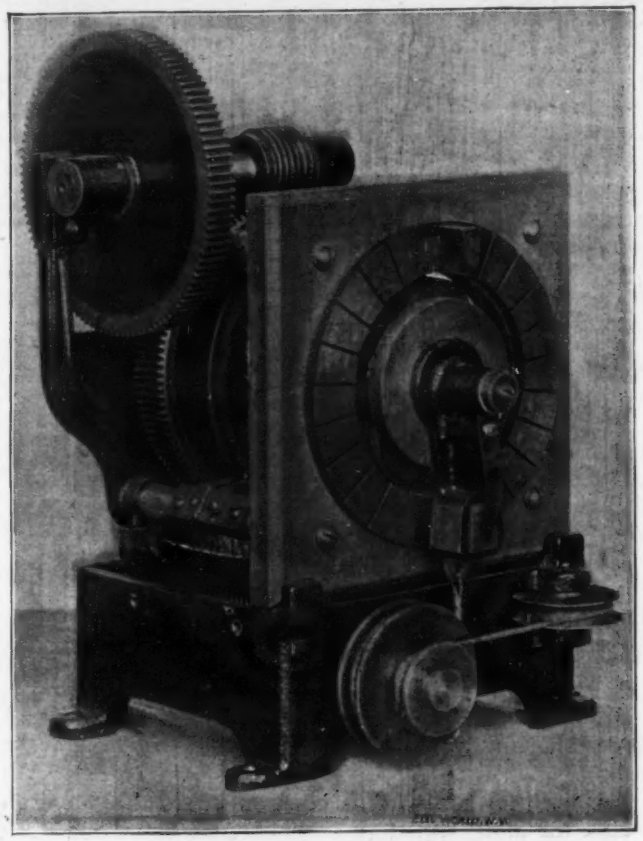
enclosed in wooden moldings, each wire having a groove by itself, and being separated from all others and from the deck or iron by at least one-half an inch of wood. The



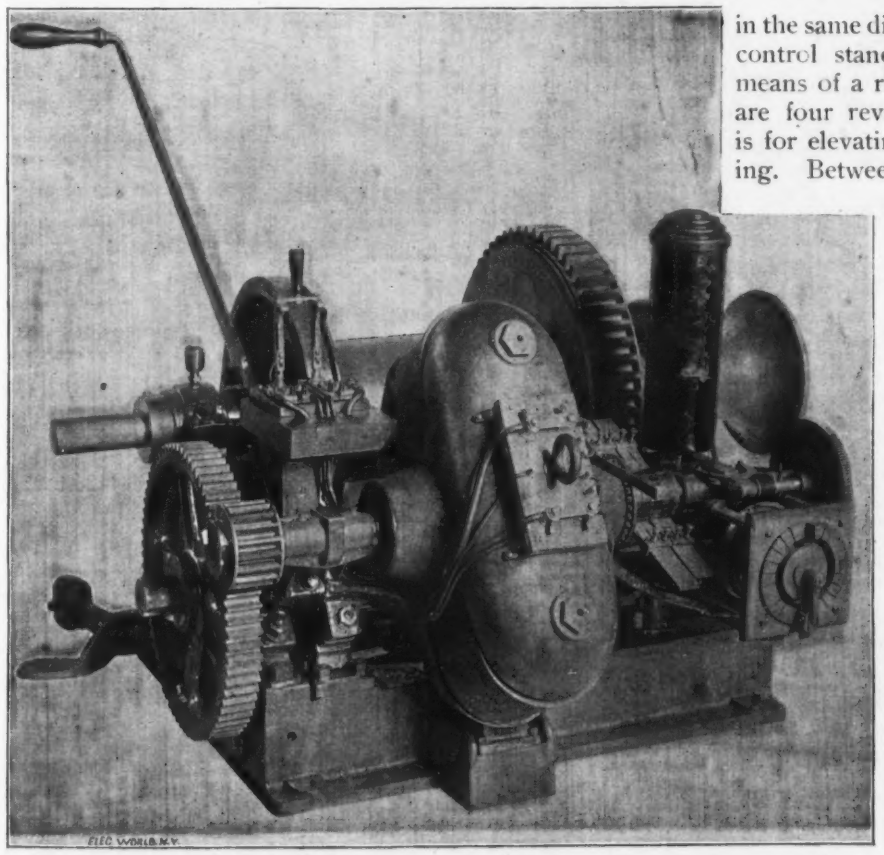
MARINE TYPE DYNAMO.

molding prevents short circuits and grounds when any injury has been done to the insulation of the wires.

The searchlights on the war vessels are of the latest type made by the General Electric Company. The accompanying illustration shows the automatic lamp. The lamps are run from the same dynamo that supplies the incandescent lamps, the voltage being reduced by means of dead resistance placed in the control stand mechanism. The dead resistance is required to steady the current in the lamp and also to prevent short circuiting while working. On the

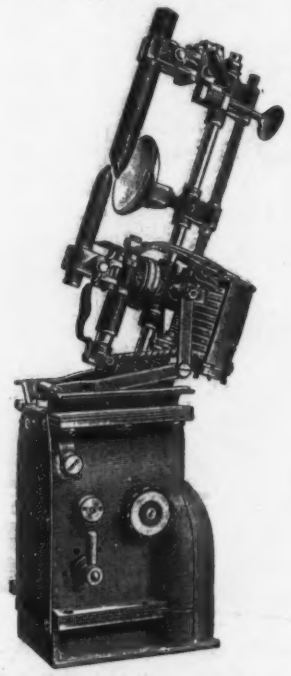


WHITE AUTOMATIC SWITCH.



ELECTRIC HOISTING ENGINE.

United States steamships New York and Columbia the searchlights are electrically controlled. By this means the elevation and training of the light are placed under the control of the operator stationed in the control stand house, usually situated on the bridge. A series motor, placed in the pedestal of the lamp and geared to the barrel, trains and elevates the lamp. The armature of the motor revolves always in the same direction, and is operated by switches placed in the control stand. The speed of the motor is regulated by means of a rheostat. Geared to the armature of the motor are four revolving electromagnets. One pair of magnets is for elevating or depressing the lamp, the other for training. Between each pair of magnets is a disc of soft iron



SEARCHLIGHT ARC LAMP.

secured to a shaft, which is connected by rods to gearing wheels. When one of the electromagnets is excited this disc is in motion, a slot engages with a pin on the magnet frame, making the disc revolve with the magnet and giving

the motion through the gearing to the lamp. The switches for operating the controlling mechanism are placed on the control stand and connected to the motor by means of an eight No. 14 B. W. G. stranded cable.

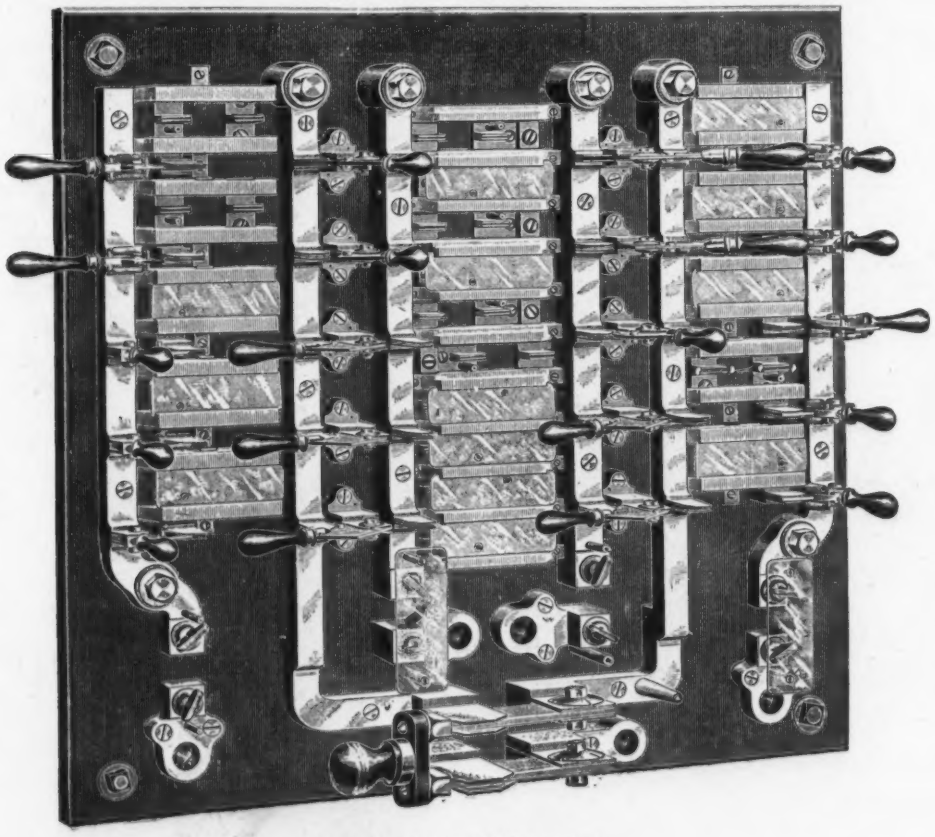
The lamps are adjusted to run on a current of from 85

ARDOIS KEYBOARD.

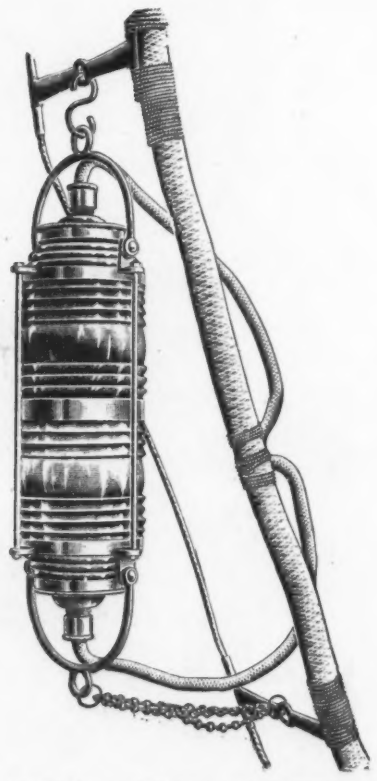
to 90 amperes at a pressure of 56 volts with a 1 1-4-inch cored Hardmuth upper carbon and a 1-inch solid lower carbon.

An interesting apparatus used on board the Government vessels for night signaling is the Ardois signal set. It consists of five double signal lanterns, similar to that shown in the illustration, each containing two lenses, one red and one white, and lighted by a 32-c. p. incandescent lamp. These lamps are connected by a stranded cable to the keyboard, an illustration of which is given, which is usually placed in the control stand house. By means of this keyboard 62 different combinations of lights can be made corresponding to a special code of signals.

The introduction of electric motors on board naval vessels has been quite prominent in the past few years. The many uses for which the electric motor is far superior to any other in convenience, weight and cleanliness recommend it for use on ventilating fans, rapid-firing guns, steering, ash hoists and workshop machinery.



NAVAL SWITCHBOARD.



ARDOIS SIGNAL LANTERN.

Aurora Borealis and Earth Currents.

To the Editor of The Electrical World :

Sir—There was a localization on the western half of the North American continent, not only of the fine aurora of Feb. 23, but also of the earth currents, affecting the telegraph lines, which, so far as is now known, after careful inquiry, were recorded only west of Chicago on that date. The day following, however, both the aurora and earth currents extended eastward, and were strongest along the Atlantic coast. This localization in longitude appears to depend primarily upon the development of a temporary magnetic system having its poles at a certain hour angle from the sun. Thus, there is concentration of effect at the meridians in the proper location to receive it at the time. Local terrestrial conditions may modify the distribution somewhat, but do not originate it, it depending upon the relative positions of sun and earth in relation to the temporary lines of force being developed at such times. The whole matter is being actively investigated by the aid of the concerted observations of the aurora which have been organized in connection with the Peary expedition, and which are proving to be successful. The authorities of the Western Union Telegraph system are becoming interested in preserving more complete memoranda of the geographical distribution of earth currents on their lines for the purpose of comparison, especially with the distribution of auroras and thunderstorms, information respecting which is now to be had in greater detail than ever.

Lyons, N. Y. M. A. VEEDER.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE eleventh annual meeting of the American Institute of Electrical Engineers in Philadelphia last week was one of the most successful gatherings which that body has ever held, and marks in a fitting manner the close of its first decade of existence. The attendance was unusual, exceeeding that of any previous meeting. The total number present approximated 150 and the large average attendance upon the daily sessions was especially gratifying. It has been too often the case in the past that the authors of the papers have been obliged to address empty chairs and the discussions have been participated in only by the faithful few. On this occasion the reverse was the case, and so many were present that a considerable portion of the audience were obliged to stand. The room where the meetings were held, unfortunately, proved much too small, but it had not been anticipated that so much interest would centre in the sessions. The discussions gave evidence of the spirit of the meeting and were so vigorously participated in that it was frequently found necessary to limit or postpone them.

The attendance was as strong in quality as quantity. There was a noticeably large percentage of the most prominent workers in the electrical field present, and the result was a series of discussions of rare importance and merit. It was unfortunate that at the close of the meeting the discussion of some of the most important papers read was necessarily cut short, but it is hoped that the printed Transactions may make amends for this loss.

The prosperity of the Institute is evidenced by the fact that the membership has now reached a total of 800, a net gain of 127 during the past year. The deaths, resignations, etc., during the past twelve months would increase this number by over fifty. The report of the council briefly reviews the progress made during 1893. For a long time the question of an official badge had been before the members, and this has been settled by the adoption of a design, which now appears upon all publications of the Institute. The work of the Institute in connection with the International Electrical Congress and the establishing of headquarters at the World's Fair by voluntary subscription reflect great credit upon its officers and members. Arrangements are now also being made for the publication of the work of the International Congress. The adoption of a plan for local meetings and the establishment of a local branch at Chicago was perhaps the most important step taken, and promises to be crowned with success. The report of the treasurer shows an encouraging balance in the treasury with which to begin the new year.

Very sincerely yours
Edwin J. Houston.

The selection of Philadelphia as the meeting place was exceedingly fortunate, as those present can abundantly testify. Not only was this a merited compliment to the Institute's genial president, but the Quaker City proved to be a most satisfactory gathering place. The hospitality of the city is far-famed, and the members of the Institute found that it had not been overestimated. The many courtesies extended to them were fully appreciated and will be gratefully remembered.

A feature of the meeting was the presence of the ladies, this being the first time in the history of the Institute that they have graced the occasion with their presence. Not only did they add to the pleasure of the sterner sex, but they thoroughly enjoyed the experience themselves and are warm in their praise of the hospitable treatment accorded them.

President Houston is entitled to the thanks of the Institute for the able and impartial manner in which he presided over the meetings, preserving dignity and equanimity under all circumstances and asserting his authority, when necessary, with such tact and geniality that it might almost be counted a pleasure to be called to order. Under his skilful guidance the programme was carried out in full, and this without sacrificing any of its essential features. All the papers were read with the exception of two, which were withdrawn by the authors, and all were given an opportunity to paritcipate in the discussion. The proceedings will be found below in detail.

The eleventh annual meeting of the American Institute of Electrical Engineers was called to order by President Houston in the assembly room of the Engineers' Club, of Philadelphia, Tuesday, May 15, at 10:30 A. M., and immediately proceeded to the transaction of routine business. At 11 A. M. Mayor Stuart was announced, and in a few graceful words welcomed the Institute and its members to the City of Brotherly Love. In extending to the members the hospitalities of the city, the mayor laid stress on a visit to the Municipal Electrical Bureau, the efficiency of which he referred to with pride. President Houston appropriately thanked the mayor for his hearty words of welcome, and said that they would be held in grateful remembrance. Prof. Trautwine, president of the Engineers' Club, after a few words on behalf of the body which had so kindly placed its facilities at the disposal of the Institute, greeted the members.

The treasurer submitted his report, showing that the Institute is in an admirable financial condition. The report showed that the receipts for the year were $10,454.60 and the disbursements $10,047.06, leaving on hand $407.54. The building fund, including accrued interest, now amounts to $905.49. A committee, consisting of George H. Hamilton and William J. Hammer, was appointed to audit accounts.

A resolution was adopted directing the Committee of Units and Standards to memorialize Congress and urge the legalization of the electrical units adopted by the Chicago Electrical Congress.

The report of the Committee on the Revision of Election Rules was received, and after a long and tiresome discussion in regard to the phraseology of several minor amendments the report was adopted.

The chairman announced invitations to visit Girard College, the power house of the Philadelphia Traction Company, the Germantown Electric Light Company, the Athletic Club of the Schuylkill Navy, La Roche Electrical Works, Queen & Co.'s show room, the Historical Society of Pennsylvania, the Edison electric light station, the factory of the Chloride Accumulator Company and the University of Pennsylvania. As the counting of the ballots was not nearly completed and there was no other business to transact, the meeting adjourned.

AFTERNOON SESSION.

The meeting of the general session was opened at 2 P. M., and the president delivered an interesting address on "A Review of the Progress of the American Institute of Electrical Engineers."

President Houston referred to the fact that the Institute had its origin in Philadelphia ten years ago, having been organized by prominent electricians connected with and in attendance on the International Electrical Exhibition of 1884. The first step was the circulation in April, 1884, by Mr. N. S. Keith, of a paper requesting signatures for the purpose of organizing an electrical society. A preliminary meeting was called on April 15 of the same year in the city of New York, at which a series of resolutions was passed and a committee or organization appointed to call a meeting, which was subsequently held on May 13, 1884, when rules were adopted and officers elected. The first regular meeting of the Institute was held in Philadelphia, Oct. 7 and 8, 1884, in one of the buildings of the Electrical Exhibition.

The president sketched the growth of the Institute and referred to the preponderating influence which its members have had upon the progress of electrical engineering, and called attention to the great and growing value of its Transactions. Stress was laid upon the valuable work of the Institute in connection with the preliminary arrangements for the Chicago Electrical Congress and its subsequent assumption of the unfinished work left by that body, on the adoption of the names of the magnetic units, and its more recent action in regard to the definition of inductance and reactance. A graceful tribute was paid to the electrical press and the affiliated professional electrical associations of Europe. It was pointed out that only in England, France and Germany are the electricians from all parts of the country concentrated in one central body comparable in importance to the American Institute of Electrical Engineers, and attention was called to the fact that the countries in which there has been so marked a progress in electrical invention and engineering are those which possess the advantages of this combined effort on the part of all its electricians. Among the benefits enumerated in the address which result from the existence of these various learned associations are the following: Concentration of effort, increased mentality excited by generous rivalry, systematic exploration into the domains of the unknown, the tacit agreement as to what shall be regarded as standards of good work, the practical establishment of a high court of last resort, by which all disputed questions in electrical engineering shall finally be settled, and the means of establishing a rapid communication of ideas between different parts of the country and the world.

The necessity of a central body for exercising the governing powers of the Institute is dwelt upon, and the evils pointed out which would be likely to follow from a neglect of this principle; on the other hand, owing to the great distances in our country the difficulty exists in all the members attending the meetings of a central body. The problem involved in these antagonistic conditions is, however, to a great extent, solved by encouraging simultaneous meetings in all parts of the country, where the same paper can be read and discussions held thereon, yet at the same time holding the governing body responsible for the proper direction of all the work of the Institute. The great success of the Chicago meeting is referred to and the hope expressed that there may soon be similar meetings held in other parts of the country where the membership will warrant it.

After referring to the bright future of the American Institute of Electrical Engineers, the advantages to be derived from co-operation are pointed out and the members reminded that it is only one of several such organizations in different parts of the world, and that the highest purposes of the science and art in which their interests are so closely centred can only be realized by the most cordial sympathy and hearty co-operation with all associated societies and their members wherever they may be.

Upon the conclusion of the President's address, which was most heartily applauded, the report of the Committee on Units and Standards, was brought up, recommending that the definition of the term "inductance" shall be identical with that of the coefficient of self or mutual induction, or L. The report stated that the opinion has been asked of the national electrical professional bodies of Great Britain, Germany, Austria and France, in regard to the definition of this term; that the two former were strongly in favor of defining it as being identical with the coefficient of self-induction; that the "Electrotechnischer Verein" of Vienna, expressed no opinion and was indifferent, and that the "Societe Internationale des Electriciens" expressed the opinion that the word should be defined as a coefficient of induction into an angular velocity. The discussion which followed was participated in by Messrs. A. E. Kennelly, C. P. Steinmetz and Dr. Bedell, the latter two favoring the French opinion, while Mr. Kennelly sustained the report of the committee. He

called attention to the fact that Mr. Oliver Heaviside originated the term to replace that of coefficient of self-induction and that the great concensus of American, English and German opinion was in favor of this view. He pointed out that at present confusion followed from the use of the term "inductance" in two senses and that this confusion would largely increase on account of the rapid extension which the branch of electrical science in which it occurs is taking. Upon a vote being taken, the report of the committee was adopted. Mr. Steinmetz then moved that the word "reactance" be adopted for that quantity in an alternating current circuit whose square added to the square of the resistance is the square of the impedance; that is, the quantity between brackets in the expression

$$C = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

This motion was warmly seconded by Mr. A. E. Kennelly and carried by a unanimous vote.

Prof. W. A. Anthony then read a paper "On the Subdivision and Distribution of Artificial Sources of Light," which discusses the distribution of light with reference to the minimum illumination of any part of the surface lighted. A given number of 16-c. p. lamps is taken, and the effect of their distribution in different ways on the illumination of various portions of a given surface calculated.

It is shown that to obtain a uniform distribution of light the lamps must be concentrated towards the outer boundary of the space instead of being equally distributed over it. The effect on the uniformity of illumination of grouping the lamps in clusters is calculated for different cases. Taking the illumination of the centre of an area as unity with a uniform distribution of 576 16-c. p. lamps, the illumination at the same place with 144 clusters of 4 lamps each is .813, and therefore if the illumination at any point in the second case is not to be less than in the first case, the number of lamps will have to be increased 25 per cent. It is also shown that the larger an area the less disparity will there be between the use of clusters and a uniform distribution of light; for example, a room 40 feet square, with 16 lamps 10 feet apart, is fully as well lighted as a room 16 feet square with 4 lamps 8 feet apart.

Referring to arc lamps, it is pointed out that their efficiency is greatly overrated, and that instead of ten times it is rarely over three times as great as that of incandescent lamps, or only one and one-half times with opal globes. With bare arcs, it is shown that unless the area to be lighted is so large as to require about 500 incandescent lamps, the use of full arcs requiring the same power will leave some parts of the area less brilliantly lighted, while in street lighting the arc is at still greater disadvantage. The opinion is expressed that the location of arcs 1,000 to 1,600 feet apart is an entire waste of money, and that a far better illumination would be had with incandescent lamps 100 to 200 feet apart.

In the discussion several members expressed their surprise at the small average candle power, less than 500, which the author gave to arc lamps, but Mr. Steinmetz and others corroborated Prof. Anthony in this respect. Mr. Kennelly called attention to the fact that while the calculations of Prof. Anthony were undoubtedly correct, the effects of diffusion and reflection would entirely change the results arrived at, and that these factors could never be neglected.

THE PLANKED SHAD DINNER PARTY.

During the afternoon session the tellers, Messrs. F. R. Upton and Geo. R. Metcalfe, appointed to canvass the vote for officers, announced that the following gentlemen had been elected: President, Edwin J. Houston; vice-presidents, W. A. Anthony, F. B. Crocker, James Hamblet; managers, A. E. Kennelly, W. D. Weaver, C. S. Bradley, W. B. Vansize; treasurer, G. M. Phelps.

The secretary read a communication from the honorary secretary of the Chicago meeting, suggesting that the Institute make some provision for the expenses of reporting the discussions of the Chicago session. After some discussion as to the sum which should be authorized and of the wording of the grant, the Institute unanimously voted to allow a sum not exceeding $10 per meeting for the expenses of a stenographic report, which amount is in excess of what was asked.

THE EVENING.

An informal reception to the members was given in the evening at the Manufacturers' Club, under the auspices of the Engineers' Club and the Electrical Section of the Franklin Institute. The handsome club rooms were thronged with members of the electrical fraternity, whose youthful appearance was evidently a surprise to more than one of the hosts. The occasion was particularly enjoyable, all of the guests being made to feel that for the time being the club was their own, and formalities of any kind were dispensed with. In one of the upper rooms ample opportunities were afforded for the refreshment of the inner man, particular care being taken that no one should suffer from the pangs of thirst. Nor were the ladies neglected and the dancing men had a free field for a display of their usefulness.

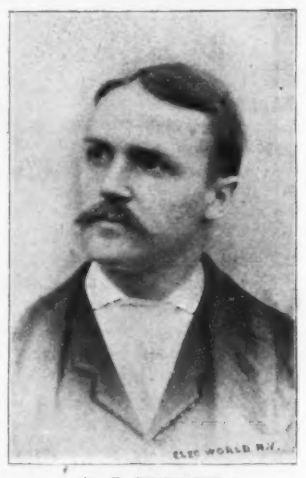
The session was opened by a paper on "Some Storage Battery Phenomena," by W. W. Griscom, which describes a number of experimental investigations of storage battery phenomena little understood. It was shown how the diverse chemical products formed at different stages of charge and discharge would largely account for the erratic form of the curves of E. M. F., and that the positive plate determines the characteristic curves of potential at times, while at other certain stages the negative plate asserts itself. The curious facts are stated that variations of capacities and even of E. M. F. exist in plates identical in history and position, and that one positive may discharge into its neighbor. It was shown that in a cell the rates of discharge of the different plates constantly varies in relation to each other. An actual decrease of temperature in a cell discharging was noted and explained as due to the simultaneous lowering of the specific gravity of the electrolyte, and it was pointed out that, contrary to usual belief, a positive plate has more capacity than a negative one. Several phenomena lacking explanations are referred to, including the changes shown in internal resistance, the simultaneous increase of internal resistance and potential, the tendency of a charged positive to buckle away from the light, and the sudden spontaneous discharge of a fully charged positive. The commercial aspects of the storage battery question are considered and the non-success in America ascribed to no allowance of a margin of safety in the weight and working of a battery, an observance of which factors has led to success in Europe.

In the discussion, Dr. Duncan referred to his experimental demonstrations of the considerable local action in plates, and to the impoverishment of the electrolyte in the plugs at high rates of discharge affecting the capacity of a cell.

The next paper on the programme was then read, that of Mr. Wurts on "Discriminating Lightning Arresters and Recent Progress in Means for Protection Against Lightning," which had been brought over from the programme of the day before. The paper is divided into three parts, the first of which describes some very interesting experiments made in Colorado, where the ordinary means of protection against lightning are entirely inadequate on account of the severity of the thunder storms. The apparatus employed was based upon the theory of "electrical surgings," that disruptive discharges form nodal points in the system, and that choke coils form points of reflection where there will be a maximum tendency to discharge. A discharge gap therefore should be connected directly in front of a choke coil. The apparatus used, consisted of choke coils and the familiar form of non-arcing metal arresters. The theory upon which this apparatus was based was substantiated by many beautiful laboratory experiments, some of which were given in the course of the paper before the Institute. The method of installation was described, and the satisfactory results obtained stated. The second section of the paper set forth a system of protection against lightning on circuits of any potential by the use of choke coils in series with the circuit. The theory of lightning discharges was taken up at considerable length. The third section was devoted to discriminating lightning arresters, two varieties being described, (a) the condenser lightning arrester; (b) the non-arcing railway arrester.

The discussion which followed was quite generally participated in, and proved to be of considerable interest.

Mr. Sachs suggested that if a considerable number of choking coils were used in series, there would be trouble from the resulting impedance. Mr. Stanley, however, stated that there would be no difficulty in this direction. Lightning discharges were of enormously high frequency, and the self-induction produced by the choking coils would hardly be appreciable. In the coil used in the experiments he estimated the choking effect to be equal to about two volts with a current of 50 amperes. He stated that the experiment shown illustrated in a beautiful manner the wave motion of the discharge and showed how it sifted off, as it were, from the various discharge points. In 1885 or 1886 he had constructed an alternating line, and as protection against lightning had put over the circuit a grounded wire. This had worked with perfect satisfaction, and he inquired if this device would not prove sufficient, at least in this section of the country. Mr. Wurts, in reply to this inquiry, stated that he knew of two cases in which such a grounded wire was used, one on Staten Island, which had worked satisfactorily, the other in Colorado, which had been a complete failure.



A. J. WURTS.

Mr. Charles Hewitt stated that the Edison company had used a grounded barbed wire for lightning protection, the wire originally being intended for a guard wire, but being found to serve a double purpose. In Philadelphia the traction companies had not only the problem of protecting the station, but the lead cables also.

Mr. Kennelly differed from Mr. Wurts as to the effect of additional turns to the choke coil above 17; he thought that impedance in the practical sense of what took place in that particular circuit under the particular conditions was meant. The impedance of the coil as actually represented in ohms would certainly increase in a continuous and marked manner. He also differed from Mr. Wurts in regard to reflecting points in the circuit. The impulse must travel along to the end of the wire unless met by some change or want of uniformity, and there is no piling up of pressure in the act of reflection. There will be no greater strains upon the insulation at the end of a wire than upon any intermediate point. In regard to an overhead wire for lightning protection, he stated that the instance cited by Mr. Wurts was the only case on record, so far as he was aware, where such a device had failed to offer protection.

Mr. Steinmetz stated that in the case of a direct lightning stroke the circuit is in the direct path of the disruptive charge, and the only thing to be done is to trust to Provi-

dence and repair what is left of the station. The branch discharge, however, can be guarded against by a ground wire or arresters. If a highly charged cloud moving over the line is suddenly discharged, the potential of the line rises very high and no ground wire will protect against the discharge currents which result. Mr. Steinmetz also described the action of choke coils in the circuit and mentioned some tests made by him on discriminating lightning arresters.

Other remarks were also made by Mr. Jenks and Mr. Harrington.

AFTERNOON SESSION.

A paper on "Unipolar Dynamos for Electric Light and Power," by F. B. Crocker and C. H. Parmly, was then read by Prof. Crocker. The object of the paper was stated to be to show that unipolar dynamos and motors are much more practical and generally applicable than is ordinarily supposed. The name "unipolar" was pronounced unsatisfactory, and "continuous pole" suggested in its stead. It was pointed out that iron or steel is much better than copper for the armature, on account of its strength, while its specific resistance is no objection on account of the great mass of metal used. A type of unipolar machine was described and formula deduced for its design. It was shown that the armature of a machine of this type for 10 volts at 1,200 revolutions need be only 27.4 inches in diameter and for 130 volts and 200 revolutions 242 inches. The capacity of the latter machine is illustrated by the statement that if two were coupled to the shaft of a 100,000-h. p. engine, they would develop more current than at present is consumed in any two cities of the world, and if run even as low as 1,000-h. p. the loss in the armature would only be four or five per cent. The great advantage of the unipolar machine in extreme simplicity is pointed out. Its armature consists of nothing but a solid cylinder or disc of steel or other suitable metal firmly mounted upon a shaft, while the construction of the field magnet and the rest of the machine is also very simple. According to accepted theories there should be no hysteresis in these machines, no Foucault currents, and probably no armature reaction. The machines would be practically indestructible, not likely to be damaged mechanically, and it is impossible to conceive of one being burned out, or otherwise injured electrically.

Those who took part in the lively discussion which followed were incredulous as to the practical merits of the unipolar dynamo. Mr. Kennelly remarked that the Ferranti armature had the advantages claimed for the type proposed, though giving an alternating current, and none of the great advantages of speed and difficulty of collection. Mr. Stanley described a somewhat similar form of unipolar dynamo he designed some years ago, but did not think any form practicable. Mr. Steinmetz also described a unipolar machine of his design, in which he solved the problem of multiplying the voltage, but denied the practicability of the unipolar principle. Mr. Hering suggested a change of the form of the field proposed and thought armature reaction would not be absent.

Prof. R. B. Owens then read a paper on a "Test of a Closed Coil Arc Dynamo," in which the rise of voltage for each bar was measured and plotted for no load, and 5, 10, 15, 20 and 25 lights, the latter being full load, and the machine a Wood arc dynamo. The results obtained show that the total induction in the armature varied very slightly with lead, and that the displacement of the neutral plane decreases with lead angle, but varies less than 10 degrees from no load to the maximum load used. The conclusions were that it would never pay to run such machines underloaded, and that if a number are used in one central station, the connections of the external circuits at the switchboard should be so manipulated as to keep the machines actually in use always loaded to as near their full capacity as possible. Regarding the relative amounts of iron in field and armature, no reason for the present practice for using so little iron in the armature, as compared with the field, is seen. The necessity of a very high field induction or a thoroughly stiff field is apparent; but why, when the lines are once generated by the field, it is not sought to collect and utilize them all by means of an armature, with a generous amount of iron, is not so easily seen. The number of commutator segments would of course have to be increased to prevent sparking, but the regulating qualities of the machine would, it is believed, be impaired. The result would be a larger output and greater efficiency. Regarding the rates of ampere turns on armature and field, such ratio will depend largely on the shape of the pole pieces and desired width of brush, but is in all cases much less than in constant potential machines.

In the discussion on Prof. Owens' paper, Mr. C. N. Black referred to the necessity of sufficient iron in the armatures of arc machines, and pointed out the error of using too high an induction there. If a sufficient amount of iron—say, to give 95,000 lines per square inch—were used in arc machines and the induction in the armature is not worked around the bend of the curve, an arc machine can be built which will be practically automatic.

Mr. Steinmetz said that he was at the same time of an opposite and the same opinion as the last speaker. He stated that the density of the iron should be very high and that 95,000 lines per square inch was such a density, though perhaps a low one in arc lighting. He referred to the fact that a good design for a constant potential machine is a bad design for an arc light machine, and that the principle of a successful arc light machine consists in having a large armature reaction; such a machine will, without shifting the brushes, keep the current practically constant under all loads.

C. P. STEINMETZ.

Prof. Anthony then read a paper by Mr. A. D. Adams on "Relative Advantages of Toothed and Smooth Core Armatures," which we print in full elsewhere. In the discussion which followed Mr. Wiener said it omitted one of the disadvantages of the toothed armature, namely, that the iron of the teeth causes a core leakage in the toothed armature, so that in such a machine, if otherwise well designed, the leakage about balances the gain, due to the reduction in the air gap. Mr. Steinmetz stated that the conclusions drawn in the paper are largely opposed to those he had derived from theoretical reasoning and practical experience. For machines like railway generators, a toothed armature is necessary, not only for mechanical reasons, but owing to the rapid changes in load, which in a smooth cored armature would cause excessive sparking. Commutation without shifting of brushes is in smooth cores out of the question. On the other hand, a smooth core machine is very desirable for ligthing where a very large current is taken off at very low voltages but a railway generator cannot be made to work with a smooth core. It is in getting rid of the shifting of the field in which the advantage of the toothed armature really lies, and this enables a very much higher efficiency to be attained with them than with the smooth core. In general, the toothed core is somewhat cheaper than the other.

Mr. Dunn said that the magnetic reluctance of the gap in the toothed core armature was not a constant, increasing as the teeth became saturated, and that the effect of saturation of the iron teeth is similar to increasing the air gap at high loads, which accounts for the less liability of such machines sparking.

Mr. Stanley referred to the extra self-induction due to the

teeth of toothed armatures, which was a cause of sparking, and in reply to a question Mr. Dunn informed him that he considered this self-induction as the greatest disadvantage of toothed core armatures.

Mr. Kennelly referred to the greater density of current that could be carried by a toothed core armature, but Mr. Steinmetz said that in the large smooth core machines the question of ventilation was not a drawback.

Prof. J. P. Jackson then read a paper on "Alternating Currents and Fuses," by Prof. Dugald C. Jackson and R. J. Ochsner, describing experiments to determine if the alternating current had any disintegrating effect on commercial fuse wires. Under the conditions of the experiment, which were those of ordinary practice, no change in the properties of the fuse due to the action of alternating currents was noted, and it was suggested that when fuses on alternating circuits blow unduly, the cause will probably be found in mechanical shaking on account of not being tightly clamped.

THE ANNUAL DINNER.

At 8:30 P. M. the annual dinner was served at the Hotel Metropole, almost a hundred chairs being occupied, and the preponderance of dress suits was so large that it is probable that few will take any chances on this score at future meetings. President Houston, as toastmaster, with a few well chosen words, introduced the various subjects and speakers, who reflected in their happy remarks the spirit of fraternalism and the elevated professional thought which have been so marked a characteristic of the Philadelphia meeting of the Institute.

Mr. George M. Phelps responded to the toast of "The Electrical Press" in a witty vein, which also showed consideration for the other members of an estate which is noted the world over for its delicate professional susceptibilities.

Mr. H. Ward Leonard, in responding to the toast of "Commercial Electrical Engineering," laid stress upon the relations which should exist between supervising and constructing engineers, and deplored the spirit so often met through which the position of the latter is rendered not only uncomfortable by the unreasonable interpretations of the former, but at times unbearable by their unwarranted suspicions and exactions.

When Mr. A. E. Kennelly arose to respond to the toast of "Mathematics and Electricity" every one had pleasurable anticipations, and when he resumed his seat the hearty and prolonged applause was evidence that his audience was not disappointed. In the most felicitous and elevated terms, Mr. Kennelly spoke of the role of mathematics in electrical science, of its almost magical character in revealing the most carefully guarded of Nature's secrets, and of its yeoman's duty in the service of the engineer. He referred to the unmerited reflections frequently made upon mathematical science and offered an eloquent plea for a recognition of the great part mathematics has played, and will continue to play, in the theory and practice of electricity.

Mr. E. G. Willyoung, in response to the toast "The Philadelphia Committee," referred to the efforts of the committee in their local work preliminary to the annual meeting, to the satisfaction its members personally felt at the fruit of their labors, and paid a merited tribute to the other gentlemen associated with him for the efficient manner in which they had discharged their arduous duties.

Mr. James Hamblet, whose subject was "Electricity and Time," alluded in humorous terms to the slight attention Time thus far had bestowed on electricity and its devotees, but warned the youthful looking audience that even electricians could not ward off its whitening hand, as he could personally testify.

"Power Transmission" was the subject most appropriately assigned to Mr. C. F. Scott, and his response showed that even such a rugged theme could be clothed in graceful words. The speaker referred to what had already been accomplished in this latest development of the great industrial applications of electricity, and his predictions as to its future were warmly applauded by the audience.

To the subject of "The Electrical Expert," Prof. W. A. Anthony did the justice expected of one of its most eminent and worthy representatives. He pointed out in words, as his practice has done in deeds, the responsibility which the electrical expert owes, not only to his client but also to the dignity of the science he represents, and condemned the misuse so frequently made of the vocation and of the name.

"Electrical Engineering Education" was the subject to which those present owed the witty and suggestive remarks of Dr. Pupin, who surprised many not only by his thorough command of an adopted language, but also by the literary art he displayed in its use. He sketched the immense progress made in the methods of electrical engineering education in recent years and referred humorously to the suspicions in regard to the utility of "a German professor with his mathematics," which existed five years ago. Since then, however, it had been recognized that mathematics is an inseparable part of an electrical engineering course and that if the engineer would take a standing in his profession, he must no longer be content with a mere manual and empirical knowledge of principles.

Prof. R. B. Owens, in responding to the toast "Electricity in the West," pointed out the great field there offered for the electrical engineer, and spoke of the use Western engineers were making of their opportunity and of the work of Western schools in fitting out the engineers of the future. He referred to the recent extension of the field of usefulness of the Institute by the inauguration of the Chicago local meeting and of the mutual benefit to both sections of the country which would follow from that action.

THE THEATRE PARTY.

A theatre party had been provided for the entertainment of the ladies, and they spent an enjoyable evening at the Broad Street Theatre, where Mr. John Drew was playing in the "Butterflies."

Mr. Elmer G. Willyoung opened the morning session by reading his paper on "Standardizing Electrical Measuring Instruments." The object of the researches upon which the paper was based was to devise a method by which the restandardizing of instruments could be done by central stations themselves. The first portion of the paper was devoted to a discussion of the potentiometer method, which, broadly speaking, consists in opposing some known proportion of the drop of an unknown E. M. F. through a given resistance to a definitely known E. M. F., the proportion being so chosen that no current is produced by the latter known source. The second section of the paper describes an improved direct reading potentiometer devised by the author, based on the form of potentiometer originally suggested by Dr. Fleming.

A paper by Prof. G. S. Moler and Dr. F. Bedell entitled "An Optical Phase Indicator and Synchronizer" was presented by Dr. Bedell. The instrument described consists of an ingenious device for measuring the angular difference in the position of two shafts running at the same speed. When

applied to a synchronous motor this instrument gives by direct reading the angle of lag of the armature of the motor behind that of the generator. It has, however, as the writers of the paper pointed out, wide application in other lines of work, as in the measurement of small speed-differences, in power-transmission between two shafts, and in work of all kinds where synchronous operation is required.

In the simplest form of apparatus described, the motor and dynamo are placed in line with ends abutting. A disc is placed on the end of each shaft. Each disc has a system of slits and when the slits of one disc cross over those of the other, a hole is formed by which light can pass through the two discs. When the discs are revolving synchronously, and a light is placed on one side of the discs, these holes appear as a ring of light. The slits in the discs are so constructed that this ring moves in or out if one disc is revolving more rapidly than the other. The distance of the ring from the centre is proportional to the angle of difference in the positions of the two discs. The apparatus is so arranged that this phase difference may be read directly.

Dr. A. C. Crehore then read his paper on "A Reliable Method of Recording Variable Current Curves." The paper proposes a method of taking current curves by means of a weightless vibrator, thus avoiding the difficulty which it seems must exist in other methods. The method of obtaining the vibrator is as follows: It is sought to influence a beam of light directly by means of the magnetic field produced by a current, so that the direction of the beam is changed proportionally with the current. The principle upon which the method depends is that discovered by Faraday, that a beam of plane polarized light has its plane rotated in passing through a magnetic field. The beam after passing the polarizer is passed through a quartz plate which naturally rotates the plane of all the rays, but the blue more than the red, according to the approxinate law that the angle is inversely as the square of the wave-length. The light then passes through a tube containing carbon bisulphide, around which the coil for the current is wound, and after passing the analyzer and slit, it is resolved into the pure colors of the spectrum. The spectrum thus obtained is the complete spectrum without that color which the analyzer neutralized, that is, there appears a dark band in the spectrum which may be moved completely across it by rotating the analyzer. This band may also be moved by passing a current through the coil. This motion takes place back and forth in exact unison with the current, and it may be so arranged that its displacement is proportional to the current. The record of this motion is obtained upon a photographic plate exposed when in motion in the well known way.

Mr. Steinmetz complimented the author upon the result of his researches, and expressed the belief that the apparatus would prove to be of great practical value and would perhaps occupy a similar relation to electrical engineering that the indicator does to steam engineering. Mr. Anthony also stated that the idea had been very beautifully worked out and had undoubted practical value.

THE EXCURSION.

One of the most enjoyable events of the programme was the plank shad dinner at Gloucester. After the morning session a private steamer, on which a refreshing lunch was provided, took the members up the Delaware to Cramp's shipyard, where they were shown the large liners and the ships which are being constructed for our Navy, besides a number of tools driven by electric motors, showing the great adaptability of such motors in cases where the tools are brought to the parts to be worked instead of bringing the work to the tools. The trip was then continued down the Delaware to Gloucester; after an excursion on the electric road and a visit to the power station, the members and guests were introduced to that famous May delicacy, a Gloucester plank shad dinner. A certain wise provision of the committee, without which the dinner and the speeches would have been dry, put everybody in a good and jovial humor, and the speakers were warned that any serious remarks would be ruled out of order. The speeches were all quite equal to the occasion and proved to be very entertaining, and it was with regrets that the members adjourned, even though it was fully an hour later than the time on the programme. A moonlight trip up the Schuylkill completed the most enjoyable day of the meeting.

THE LADIES.

The ladies were entertained at luncheon at the Manufacturers' Club and in the afternoon by a very pleasant tally-ho excursion.

A committee appointed to consider the advisability of the Institute adopting "the National Electric Light Association's standard rules for electrical construction and operation" reported that in the short time at its disposal it would have been impossible to make the examination and report on the rules necessary before placing the matter before the Institute for action.

Dr. M. I. Pupin read his paper on "Resonance Analysis of Alternating and Polyphase Currents," which, in some respects, is a continuation of his epoch making paper on resonance read before the last annual meeting of the Institute. The introduction points out the advantages of knowing the form of alternating current waves and states the method of resonance analysis offers a simple, sensitive and accurate method. A description of the method used is then given, with experimental tests, and the conclusion arrived at that a resonator of the type employed is quite capable of detecting all the frequencies that may exist in an alternating current wave, that its indications are in good agreement with the theory as far as the fundamental frequency is concerned, and that it gives a fairly approximate idea of the relative strength of the harmonics. Next is an account of experiments to determine the location of the origin of upper harmonics, and the conclusions arrived at are that a ferric self-inductance in circuit with an alternator which gives a simple harmonic E. M. F. distorts the current by introducing higher odd harmonics, principally the harmonics of three times the frequency of the fundamental, and that this and probably all other harmonics increase proportional to the excitation; with this ferric inductance as a transformer, the distortion appears slightly in the secondary if the transformer has an open magnetic circuit, but negligibly with a closed one; a practically simple harmonic E. M. F. is produced by alternators with smooth core armatures, even if the latter are worked at a high rate of magnetization; a slotted core armature produces a complex harmonic E. M. F. in which the upper harmonic of three times the frequency of the fundamental is by far the strongest, and the amplitude proportional to the excitation, or the magnetization of the armature; a ferric inductance in circuit with a slotted core armature introduces no new harmonics, and seems to strengthen the odd harmonics.

It is also shown that the odd harmonics are present undiminished at all loads, though sometimes masked. As to secondary circuits, it is pointed out that the primary corresponds to an alternator and the origin of the secondary's harmonics is therefore in the primary. An analysis of the rotary field is described, which showed that such fields pro-

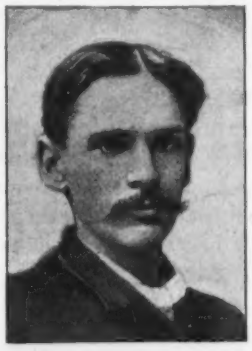
duced by reasonably well constructed machines are not accompanied by fluctuations.

The view of the author as to the cause of upper harmonics is that they are not due to hysteresis, but will be generated whenever more or less abrupt changes of the magnetic state in any part of the magnetic field through which an alternating current flow occurs, as by the use of slotted armatures. The final conclusion is given that there is no cure against harmonics in circuits containing iron.

In the discussion Prof. Anthony said that he never could see any reason why the rotary field should be considered complicated, and that it followed as a matter of course from the principles concerned that its intensity should be constant. Mr. Steinmetz stated that the phenomenon of resonance can be explained from well known laws without considering it as a special phenomenon, and that it is not different from the well known action of the choking coil producing an E. M. F. 90 degrees behind the current and thereby, according to the phase relation between currents and impressed E. M. F., either reducing the E. M. F. if the current is lagging or increasing it if the current is leading.

Mr. Kennelly considered that the beautiful method described by Dr. Pupin is necessarily and fundamentally weak in one important particular, and that is that while it brings out the harmonics in any periodic wave E. M. F., it does not bring out, and cannot bring out, the phase relation of these harmonics; consequently you can have a large harmonic in an alternating E. M. F. and the shifting of the phase will produce an enormous difference in the shape of the wave whether it be in step or not, so that as you shift it along the consequence may be so great as to totally offset the conclusions based on observation. In reply to this Dr. Pupin said that it does not make any difference whether there is an infinite number of phase relations, and that no one cares for the exact shape of an alternating current wave and that we do not even care whether the harmonic is in phase with the fundamental or not, provided that phase directions will not affect our results and experiments, as has been shown.

Mr. A. E. Kennelly then read a paper by Dr. Louis Bell on "Some Facts About Polyphase Motors." Stress was laid upon the fact that a properly designed induction motor can be run like a continuous current series motor at different speeds, and also has a similar efficiency at such speeds. A misapprehension in regard to the power factor of polyphased currents was referred to, and it was shown that the

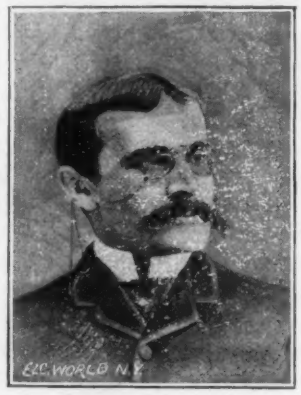


WILLIAM STANLEY, JR.

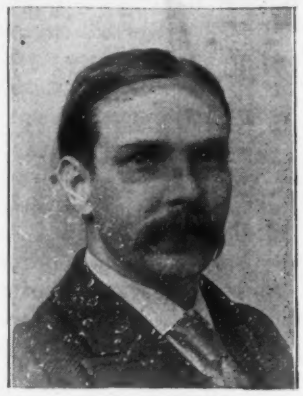
W. A. ANTHONY.

power factor only varies slightly for large variations in load from full load, and becomes notably reduced only at small loads. The admirable regulating qualties of induction motors were illustrated by curves, and a great advantage of such motors pointed out in their immunity from being burned out.

Mr. C. P. Steinmetz gave a synopsis of a continuation (Part III.) of his classical paper "On the Law of Hysteresis," only a portion of which had been printed, and the remaining copy was at the printer's. He referred to the confirmation of his former conclusion by others, and stated that recent analyses of iron have given hysteretic losses much below that quoted by Ewing, and previously by himself. A chapter of the paper is devoted to defining the difference between molecular friction and hysteresis, and the conclusion stated



LOUIS DUNCAN.

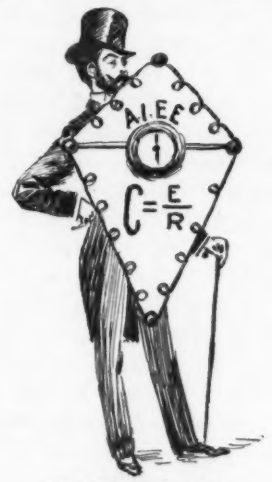


A. E. KENNELLY.

that magnetic hysteresis is not identical with molecular magnetic friction, but one of the phenomena caused by it.

Dr. Louis Duncan gave an account of some "Experiments with Two-phase Motors" illustrated by curves showing simultaneous values in the two circuits; in a future issue we will publish the paper in full.

A paper on "Reactance," by C. P. Steinmetz and F. Bedell was read by title. The meeting then adjourned.



HOME AGAIN.

The following is a list of those in attendance:

Philadelphia.

J. G. Biddle, C. Billberg, A. Braddell, Chas. A. Bragg, J. Martin Brill, W. I. Chesney, A. Childs, W. E. Culbertson, W. P. Dallett, F. W. Darlington, W. A. Drysdale, W. C. L. Eglin, H. P. Farington, S. G. Flagg, Frank R. Ford, I. P. Gaylord, F. W. Glading, W. W. Griscom, C. H. Harris, John Hoskin, Carl Hering, Chas. Hewitt, F. H. Hochrath, E. J. Houston, R. M. Hunter, J. D. Israel, A. Langstaff Johnston, E. R. Keller, A. E. Kennelly, R. H. Klander, F. L. Knight, E. K. Landis, Winford Lewis, R. McK. Lloyd, W. D. Marks, A. P. Mayers, L. K. Perot, C. W. Pike, G. B. Price, A. L. Register, A. J. Rowland, E. A. Scott, Franklin Sheble, L. N. Shultz, H. L. Snyder, Thos. Spencer, J. F. Stevens, E. S. Stewart, C. W. Swoope, F. E. Swope, Jr., J. C. Trautwine, Jr., F. Uhlenhaut, H. P. White, P. Winands, E. G. Willyoung, C. P. Wilson, Peter Wright.

New York.

Harold Binney, C. S. Bradley, H. S. Chase, S. L. Coles, F. B. Corey, F. B. Crocker, H. M. Davis,Gano S. Dunn, C. E. Emery, Henry W. Frye, P. G. Gossler, Jas. Hamblet, W. J. Hammer, W. F. Hanks, W. R. Hewitt, Cary T. Hutchinson, W. J. Johnston, J. M. Knox, A. A. Knudson, N. W. Perry, Geo. M. Phelps, R. W. Pope, M. I. Pupin, H. Ward Leonard, W. B. Lester, O. T. Louis, J .C. Martin, Geo. Metcalfe, J. R. Moses, W. A. Mosscroft, J. W. T. Olan, Rich. Pfund, H. D. Reed, Chas. T. Rittenhouse, Joseph Sachs, L. Stieringer, J. R. Taltavall, H. C. Townsend, F. R. Upton, W. D. Weaver, N. D. Webster.

Baltimore.

Louis Duncan, J. C. George, H. S. Hering, S. Riber, T. M. Thomas.

Schenectady.

T. V. Bolan, H. G. Reist, C. P. Steinmetz, F. W. Tischenderfer, A. E. Wiener.

Pittsburgh.

E. E. Keller, C. F. Scott, A. J. Wurtz.

Elsewhere.

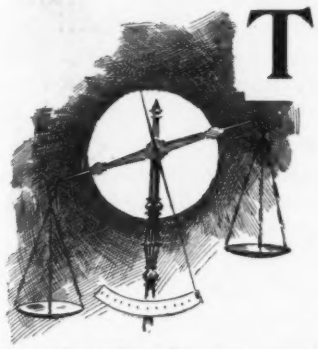
Ansonia, Conn.—G. G. Grover; Bridgeport, Conn.—Leonard Waldo; Brooklyn, N. Y.—P. G. Grulen; Camden, N. J.—W. E. Harrington; Cleveland, Ohio—C. N. Black; East Orange, N. J.—F. E. Jackson; Frankfort, Germany—Fred. Cornell; Hanover, N. H.—A. C. Crehore; Hartford, Conn.—F. G. Waterhouse; Ithaca, N. Y.—Fred. Bedell; Lincoln, Neb.—R. B. Owens; Manchester, Conn.—John Waring; Maywood, N. J.—C. O. Jaeger; Minneapolis, Minn.—Morgan Brooks; Newark, N. J.—E. A. Colby, R. O. Heinrich; Passaic, N. J.—S. D. Mott; Pittsfield, Mass.—Wm. Stanley; Rutherford, N. J.—Alfred Buys; St. Paul, Minn.—M. H. Gerry; Sharon Hill, Pa.—C. R. Arnold; State College, Pa.—J. P. Jackson; Troy, N. Y.—E. G. Bernard; Vineland, N. J.—W. A. Anthony; Westchester, Pa.—Arthur Hoops; West Hoboken, N. J.—F. Reckenzaum; Wilmington, Del.—J. A. Hall, C. R. Van Trump.

The Ladies.

Mrs. C. S. Bradley, New York; Mrs. W. E. Harrington, Camden, N. J.; Mrs. A. Langstaff Johnston, Philadelphia; Mrs. W. J. Johnston, New York; Mrs. A. A. Knudson, New York; Mrs. A. B. See, Brooklyn; Mrs. Franklin Sheble, Philadelphia.

Relative Advantages of Toothed and Smooth Core Armatures.*

BY ALTON D. ADAMS.



THE merits of different methods of construction in the manufacture of dynamo electric machinery, as in other lines, must evidently be decided by their comparative costs, all else being equal. Although questions concerning the relative merits of toothed and smooth core armatures have long been discussed, very little seems to have been written to show whether actual saving in cost may be effected by one construction over the other when employed to produce the same results.

The practice of dynamo builders in this country, and abroad embodies both types, and the history of the art records many changes from each to the other. In view of the above, the inquiry whether in the light of present facts any saving can be effected by the use of toothed core armatures seems of interest.

The limits of this paper do not permit consideration of this question in connection with all classes of electrical machinery, and its bearing on direct current constant pressure machines only will be taken up.

The principal disadvantages of toothed compared with smooth core armatures are greater first cost, large change of lead, excessive sparking when used with too short air gaps, and the production of heat in pole pieces; their advantages are, that inductors are positively driven, large solid inductors, protected from eddy currents, and that a reduction may be made in the length and consequent magnetic resistance of the air gap.

Change of lead may be fixed within any desired limits, and sparking abated by such proportions of air gap and teeth as give them sufficient magnetic resistance.

Heat in pole pieces may be reduced by their lamination, by the use of very narrow teeth and slots, by forms of teeth that present a nearly continuous surface of iron to the pole pieces, and still more, by the use of openings in core discs which do not cut through their outside surface, or a continuous magnetic sheath outside the teeth. For any given form of tooth, the heating is less the longer the air gap.

The mechanical strength of armature teeth, as usually employed, is far in excess of that required to hold inductors in position, even under conditions of short circuit, and driving pins inserted in the core, at proper intervals, are much cheaper and take up less valuable room on the armature circumference. Either teeth or substantial driving pins are, of course, preferable mechanically to the slender bits of hard fibre which have been much used, and often give way under the heavy strains to which large generators are subject.

When large wires or copper rods are used as inductors, their protection from eddy currents is an important matter, but proper stranding of inductors reduces the eddy loss in them, when used on smooth cores to a very small amount, and has the further important advantage that inductors may be bent into the proper shape at armature ends, and the joints, necessary when rods are used, avoided.

The chief possible advantage, then, to be gained by the use of toothed armatures is through a reduction in the length of the air gap, and the consequent reduction in the ampere turns required on field magnet, weight of copper, or energy in winding, and the length and weight of iron core. To make this advantage available, it must be practical to use air gaps shorter than are required for insulation, winding and clearance.

As is well understood, the armature winding of a dynamo or motor, in operation, has a magnetizing action which is measured in ampere turns for a bipolar machine by one-quarter the product of all the inductors of the armature into the total armature current. The ampere turns on the armature evidently tend to set up a flow of magnetism, having a complete circuit through the armature core, twice across each air gap, and through the iron of pole pieces.

About half the ampere turns furnished by the inductors under pole pieces evidently act against the field ampere turns in each air gap at the polar tips, and the ratio between the armature and field ampere turns at this point, necessary to give sparkless reversal there, must determine whether the required magnetic resistance be greater or less than that of an air gap long enough for insulation, winding, and clearance with a smooth core armature.

As an armature coil in an operating dynamo or motor passes under the brush, the current flowing in it must stop, and one in the opposite direction be set up; and if this action is to be accomplished without sparking a sufficient electromotive force must be provided in the coil while in direct contact with the brush. In the ordinary dynamo or motor magnetism forced across the path of the coil, by the field ampere turns expended in air gap, must provide this reversing electromotive force.

The data of a number of smooth core armature machines of different make show ratios of field to armature ampere turns in air gap of from about one and one-half to one, to two and one-half to one, and the writer's experience is that a ratio of two to one will give sparkless operation at full load, with brushes set just outside pole corners.

It is a matter of common experience that the ratio between field and armature ampere turns in the air gap may be so reduced, even in machines with smooth core armatures, as to require excessive change of lead to secure even approximate freedom from sparking.

If it be desired therefore to build machines having an expenditure of field ampere turns in the air gap not much greater than those of the armature, we need not resort to toothed cores.

Take, for example, the case of a 260-ampere dynamo, with 120 inductors on its armature in one layer, an air gap induction of 25,000 lines per square inch, and 80 per cent. of inductors under the pole pieces. An air gap of .45 inch between the armature and each pole piece will be sufficient for insulation, winding and clearance, and the field ampere turns expended in each air gap will therefore be 3,500, while the armature ampere turns, active under each pole tip, will be 3,100. A considerable change of lead and sparking can be readily predicted for this machine.

In some types of small machines the room required by insulation, winding and clearance makes the air gap longer than necessary for sparkless operation, and in such machines

* A paper read at the eleventh annual meeting of the American Institute of Electrical Engineers.

the utility of teeth seems to depend on their cost compared with the saving to be effected by their use.

As the ampere turns furnished by the inductors under any pole piece grow less in a machine of given capacity when the number of poles is increased, very short air gaps may be used if the number of poles is sufficiently large.

As an increase in the number of poles usually makes a machine of given capacity more expensive, however, the question at once comes up to what extent the number of poles may be increased without a greater expenditure than the saving of iron and copper to be effected.

In large multipolar machines of four or six poles, such as are commonly used, the length of air gap required for sparkless operation is considerable, and those who have watched the development of these machines with toothed core armatures during the last four or five years have seen the air gaps gradually widen, until machines of this character are not hard to find in which the copper inductors between the teeth could be taken out, wound outside the teeth, and still leave room enough for good clearance.

Additional mechanical security, of course, furnishes a considerable argument for the use of teeth in very large slow speed machines.

A number of devices have been suggested from time to time to enable toothed core armatures to be used with short air gaps, and the consequent saving in iron and copper effected. No machines with these devices, however, have yet stood the test of time and competition with those of ordinary type, and have yet to prove their ability to produce results as at present attained at a less cost.

The seeming opportunity to save material by the use of toothed armatures is very attractive, and we cannot but hope it may some day be practical; in the light of present knowledge, however, there seems little to be gained by their use in medium and large bipolar machines.

Inductance and Reactance.

An important step was taken by the American Institute of Electrical Engineers at its general meeting last week in adopting definitions for the technical terms "inductance" and "reactance." The former has been in use for some time, but, unfortunately, has been subject to ambiguous usage, while the latter, although suggested about a year ago, had not received general acceptation.

Mr. Oliver Heaviside, finding that he had very frequently to employ the cumbrous terms "coefficient of self-induction" and "coefficient of mutual induction" in his writings, decided to adopt the word "inductance" for a "coefficient of induction" with the specification "self-inductance," or "mutual-inductance," whenever distinction became necessary. This term was introduced consistently with his system of terminology, in which the suffix -ance, as in the word resistance, denoted a property of matter prescribed by the form of a body, and the suffix -ivity, or -ity, as in the word permeability, for a property of matter considered independently of the form of a body. According to Mr. Heaviside's original proposal, therefore, a coil of wire possesses a definite inductance expressible in centimetres or quadrants, or, as we now express it, in henrys.

Whether by misapprehension or by independent invention, it is now difficult to say, the word inductance subsequently found a new and different application. It was applied to the component of spurious, or wattless, resistance, which compounds rectangularly with the real or ohmic resistance in an alternating current circuit, to form the apparent resistance or impedance of that circuit. In this second sense of the term, the square of the resistance of such a circuit, added to the square of the inductance, gave the square of the impedance. This made inductance a quantity of the nature and dimensions of resistance, except that it was a resistance that did not dissipate the energy of a current. Most of the French writers employed "inductance" in the sense of a resistance of this nature. In England and America writers were divided, some using it in one sense and some in another. In German literature the term did not take root, possibly owing to this very ambiguity.

This was the state of affairs in this matter in 1893, when the Congress committee of the American Institute of Electrical Engineers drew up its report. In this report a definition for the word "inductance" was suggested as worthy of the attention of the Chicago International Electrical Congress. But the Chamber of Delegates did not pass any resolutions on the subject of nomenclature, so that the ambiguity in the use of this term still continued unchecked.

The American Institute, after the conclusion of the Chicago Congress, followed up the matter, and in order to avoid, if possible, the continuation of confusion until the next International Electrical Congress should be convened, appealed to four of the leading European electro-technical institutions for their views upon the meaning that should be given to this term. The London Institution of Electrical Engineers supported the original definition of Mr. Heaviside. The French Societe Internationale des Electriciens referred to the report of its committee that was appointed in 1893, to consider the Chicago Congress proposals, and in this report, although the word inductance was not mentioned, it was advocated that the older phrases, coefficient of self or mutual induction, should undergo no change. It also advocated, however, that the word "reactance" might suitably be employed for that wattless resistance in an alternating current circuit, to which the term inductance was frequently applied. The "Physikalisch Technische Reichsanstalt" in its reply to the American Institute appears to have gracefully accepted the meaning of the originator of the word inductance.

On the recommendation, therefore, of its Committee on Units and Standards, the American Institute of Electrical Engineers, at the annual meeting held last week, formally adopted the meaning of a coefficient of induction, in conformity with the English and German Institutions.

At the same time, the Institute has also adopted the recommendation of the French Societe Internationale concerning the word "reactance," which should therefore take the place of the rejected use of the term inductance. Reactance, in a circuit traversed by a periodic current, is therefore that quantity whose square, added to the square of the resistance, gives the square of the apparent resistance or impedance. A more accurate definition is to be submitted to the Institute for consideration by Messrs. Steinmetz and Bedell.

The dimension of inductance, in the electromagnetic system of units, is simply a length, and it is measured in henrys; the dimension of reactance is the same as that of resistance and the values of reactances may be expressed in ohms.

We sincerely hope that for the sake of conformity, the action of the Institute will be everywhere upheld; that all writers will now use the terms inductance and reactance with the meanings adopted and recommended by the Institute.

During the reading of a paper by Mr. Steinmetz, he suggested the use of the term "admittance" to represent the reciprocal of "impedance" just as "conductance" is the reciprocal of "resistance." As the total admittance of several circuits in parallel will be the sum of their separate admittances, the use of this term greatly simplifies the discussion of such circuits and avoids having to say that the total impedance of such circuits is equal to the reciprocal of the sum of the reciprocals of the individual impedances. Some writers are doubtless already familiar with this term, as it was suggested some time ago. No action was taken by the Institute, but if the term proves to be acceptable, something should be done to prevent the use of other terms for this quantity, or the use of this word in any other sense.

Practical Notes on Dynamo Calculation.—II.*

BY ALFRED E. WIENER.

4.—*Field Density.*

The specific strength of the magnetic field has to be chosen according to the size of the machine, the number of poles, the form of the armature, and to the material of the pole pieces. In general, the higher a density of the magnetic lines per unit of field area is taken, the larger the output of the dynamo, and in multipolar machines greater values of $\mathfrak{H}$ are admitted than in bipolar ones. In dynamos with smooth core armatures the field densities are greater than in those with toothed armature bodies; for in the latter a portion of the lines enters the teeth and passes through the armature without cutting the conductors; for such armatures it therefore takes more lines per square inch of pole area to produce the same field density (per square inch of area occupied by armature conductors) than for smooth cores, and consequently smaller field densities are to be taken in order to prevent over-saturation of the pole pieces, and, eventually, of the frame. This leakage through the armature takes place in the higher degree the greater the width of the teeth compared to that of the slots, and therefore still smaller field densities are to be chosen in case of armature cores with tangentially projecting teeth, and of those with closed slots. Finally, in machines having wrought iron or steel pole pieces, the densities can be taken about 50 per cent. higher than in those with cast iron pole shoes.

TABLE IV.—PRACTICAL FIELD DENSITIES IN ENGLISH MEASURE.

Field Densities, in Lines of Force per square Centimeter

Capacity in Kilo Watts	Bipolar Dynamos						Multipolar Dynamos						Capacity in Kilo Watts
	Smooth Armature Core		Toothed Armature Core				Smooth Armature Core		Toothed Armature Core				
			Straight Teeth		Projecting Teeth				Straight Teeth		Projecting Teeth		
	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	
.1	1550	2300	1250	1850	—	—	2150	3100	1850	2800	—	—	.1
.25	1850	2800	1550	2300	—	—	2500	3700	2150	3250	—	—	.25
.5	2150	3100	1850	2800	—	—	2800	4200	2500	3700	—	—	.5
1	2300	3400	2000	2950	1250	1850	2950	4350	2650	3850	1550	2300	1
2.5	2500	3700	2150	3100	1400	2150	3100	4500	2800	4000	1700	2500	2.5
5	2650	3850	2300	3400	1550	2300	3250	4700	2950	4350	1850	2800	5
7.5	2800	4000	2500	3700	1700	2500	3400	5000	3100	4700	2000	3100	7.5
10	2950	4350	2650	3850	1850	2800	3700	5400	3250	5000	2150	3300	10
25	3100	4700	2800	4200	2000	3100	4000	5900	3400	5400	2300	3500	25
50	3400	5100	3100	4700	2150	3400	4350	6400	3550	5900	2500	3700	50
100	3700	5600	3400	5100	2500	3700	4700	6800	3850	6300	2650	3850	100
200	4200	6200	3700	5600	2800	4200	5000	7300	4200	6500	2800	4000	200
300	4700	7000	4200	6200	3100	4700	5400	7750	4500	6800	2950	4350	300
500	—	—	—	—	—	—	5900	8200	4800	7200	3100	4700	500
1000	—	—	—	—	—	—	6400	8700	5100	7500	3400	5000	1000
2000	—	—	—	—	—	—	7000	9300	5400	7800	3700	5400	2000

TABLE V.—PRACTICAL FIELD DENSITIES IN METRIC MEASURE.

Field Densities, in Lines of Force per square inch

Capacity in Kilo Watts	Bipolar Dynamos						Multipolar Dynamos						Capacity in Kilo Watts
	Smooth Armature Core		Toothed Armature Core				Smooth Armature Core		Toothed Armature Core				
			Straight Teeth		Projecting Teeth				Straight Teeth		Projecting Teeth		
	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	Cast Iron Polepieces	Wr't Iron or Steel Polepieces	
.1	10000	15000	8000	12000	—	—	14000	20000	12000	18000	—	—	.1
.25	12000	18000	10000	15000	—	—	16000	24000	14000	21000	—	—	.25
.5	14000	20000	12000	18000	—	—	18000	27000	16000	24000	—	—	.5
1	15000	22000	13000	19000	8000	12000	19000	28000	17000	25000	10000	15000	1
2.5	16000	24000	14000	20000	9000	14000	20000	29000	18000	26000	11000	16000	2.5
5	17000	25000	15000	22000	10000	15000	21000	30000	19000	28000	12000	18000	5
7.5	18000	26000	16000	24000	11000	16000	22000	32000	20000	30000	13000	20000	7.5
10	19000	28000	17000	25000	12000	18000	24000	35000	21000	32000	14000	21000	10
25	20000	30000	18000	27000	13000	20000	26000	38000	22000	35000	15000	23000	25
50	22000	33000	20000	30000	14000	22000	28000	41000	23000	38000	16000	24000	50
100	24000	36000	22000	33000	16000	24000	30000	44000	25000	40000	17000	25000	100
200	27000	40000	24000	36000	18000	27000	32000	47000	27000	42000	18000	26000	200
300	30000	45000	27000	40000	20000	30000	35000	50000	29000	44000	19000	28000	300
500	—	—	—	—	—	—	38000	53000	31000	46000	20000	30000	500
1000	—	—	—	—	—	—	41000	56000	33000	48000	22000	32000	1000
2000	—	—	—	—	—	—	45000	60000	35000	50000	24000	35000	2000

* In the first section of this serial, on page 676, the symbol F has been used to denote the field density; hereafter, the symbol $\mathfrak{H}$ will be employed for the field intensity, in accordance with the congress notation of 1893. All who intend to follow this treatise are advised to make the substitutions indicating this change of notation, as reference will be made to formula (1) in future sections.

The suitable values of $\mathfrak{H}$ for all these various cases are tabulated in Table IV., which gives the average densities in lines of force per square inch, while Table V. contains the corresponding values of $\mathfrak{H}$ in lines per square centimetre.

For very low potential machines (electro-plating dynamos, battery motors, etc.), about 3-4 of the densities given in Tables IV. and V. are to be taken.

5.—*Length of Active Armature Conductor.*

By means of the specific armature induction obtained from formula (1), the total length of active wire to be wound upon the pole facing surface of any armature can be readily determined. If E denotes the total E. M. F. generated in an armature, and L_a the total length of active wire wound on it, then E divided by L_a will give the specific armature induction V. The length of active conductor for any armature can therefore be obtained from the formula

$$L_a = \frac{E}{V}, \qquad (2)$$

in which

L_a = total length of active conductor (on whole circumference opposite pole-pieces), in feet;

E = total E. M. F. to be generated in armature, i. e., volt. output + additional volts to be allowed for internal resistances (see Table VI.); and

V = specific induction of active armature wire, calculated by formula (1).

Introducing the value of V from (1) into (2), the formula for the length of active armature conductor becomes:

$$L_a = \frac{E}{\frac{v}{P} \times S \times \frac{\mathfrak{H}}{20000}} = \frac{20000 \times P \times E}{v \times S \times \mathfrak{H}} \qquad (3)$$

To find the total electromotive force, E, to be generated by the armature, increase the electromotive force, e, wanted in the external circuit, by the percentages given in Table VI. The figures in the second column of this table refer to shunt wound dynamos, and, therefore, take into account the armature resistance only. The percentages in the third and fourth columns are to be used for series and for compound wound dynamos, respectively, and, consequently, include allowances for armature resistance as well as for series field resistance.

TABLE VI.—E. M. F. ALLOWED FOR INTERNAL RESISTANCES.

Capacity in kilowatts.	Additional E. M. F., in per cent. of output E. M. F.		
	Shunt dynamos.	Series dynamos.	Compound dynamos.
Up to .5	20% to 12%	40% to 25%	30% to 20%
" " 1	12 " 10	25 " 20	20 " 15
" " 2.5	10 " 8	20 " 16	15 " 12
" " 5	8 " 7	16 " 14	12 " 10
" " 10	7 " 6	14 " 12	10 " 8
" " 25	6 " 5	12 " 10	8 " 7
" " 50	5 " 4	10 " 8	7 " 6
" " 100	4 " 3½	8 " 6	6 " 5
" " 200	3½ " 3	6 " 5	5 " 4
" " 500	3 " 2½	5 " 4	4 " 3
" " 1,000	2½ " 2	4 " 3	3 " 2½
" " 2,000	2 " 1½	3 " 2½	2½ " 2

6.—*Size of Armature Conductor.*

The sectional area of the armature conductor is determined by the strength of the current it has to carry. For general work, the current densities usually taken vary between 400 and 800 circular mils per ampere; in special cases, however, a conductor area may be provided at the rate of as low as 200 to 400 circular mils per ampere, or as high as 800 to 1,200 circular mils per ampere. The low rate refers to machines which only are to run for a short while at the time, as, for instance, motors to drive special machinery (private elevators, pumps, sewing machines, dental drills, etc.), while the high rate is to be employed for dynamos which have a 15 or 20 hours' daily duty, as is the case for central station, power house, and marine generators, etc.

Taking 600 circular mils per ampere as the average cur-

ent density (= 475 square mils, or .000475 square inch per ampere, or about 2,100 amperes per square inch), the sectional area of the armature conductor, in circular mils, is to be

$$\delta_a{}^2 = 600 \times \frac{C}{2P} = \frac{300 \times C}{P} \qquad (4)$$

where $\delta_a{}^2$ = sectional area of armature conductor, in circular mils;

δ_a = diameter of armature wire, in mils;

C = total current generated in armature, in amperes; and

P = number of pairs of magnet poles.

The size of conductor may be taken from the wire gauge tables by selecting a wire, the sectional area of one or more of which makes up, as nearly as possible, the cross-section obtained by formula (4).

In this formula, as in equation (1), half the number of parallel armature circuits is to be substituted for P, in case the former figure should differ from the latter.

The total armature current, C, in shunt and compound dynamos is the sum of the current output, c, and the exciting current of the shunt circuit. The latter quantity, however, generally is very small compared to the former, and in all practical cases, consequently, it will be sufficient to use the given c instead of the unknown C for the calculation of the conductor area. A supplementary allowance may, then, be made by correspondingly rounding off the figures obtained by (4), or by selecting the wires of such a gauge that the actual conductor area is somewhat in excess of the calculated amount.

7.—*Diameter of Armature Core.*

If the speed of the dynamo is given, the proper conductor velocity taken from Table III. will at once determine the diameter of the armature. Let N denote this known speed, in revolutions per minute, and d'_a the mean diameter of the armature winding, in inches, then the cutting speed, in feet per second, is

$$S = \frac{d_a \times \pi}{12} \times \frac{N}{60}, \qquad (5)$$

from which follows:

$$d'_a = \frac{12 \times 60}{\pi} \times \frac{S}{N} \times 230 = \frac{S}{N} \qquad (6)$$

From this mean winding diameter, d'_a, then, the diameter of the armature core, d_a, is found by making allowance for the height of the armature winding. For small armatures—under two feet in diameter—the coefficients given in Table VII. may be used for this purpose; for larger ones it is sufficient to simply round off the result of formula (6) to the next lower round figure.

TABLE VII.—RATIO BETWEEN DIAMETER OF BODY AND MEAN WINDING DIAMETER FOR SMALL ARMATURES.

Size of armature.	Diameter of armature core. Drum armatures.	Diameter of armature core. Ring armatures.
Up to 3 in. diameter.	$d_a = .88 \times d'_a$	
" 6 in. "	$= .92 \times d'_a$	$d_a = .94 \times d'_a$
" 12 in. "	$= .95 \times d'_a$	$= .96 \times d'_a$
" 18 in. "	$= .96 \times d'_a$	$= .97 \times d'_a$
" 24 in. "	$= .97 \times d'_a$	$= .98 \times d'_a$

For dynamos with internal poles, the reciprocals of these coefficients are to be taken, or the result is to be rounded off to the next higher round figure, respectively; and the dimension thus obtained is the internal diameter of the armature core. In the case of machines with internal as well as external poles, the mean winding diameter, d'_a, is identical with the mean diameter of the armature body.

If the speed of the dynamo is not given, the following Tables VIII., IX. and X. will be found useful. Table VIII. gives practical data for speeds, conductor velocities, and corresponding diameters of drum armatures. Table IX. contains similar information relating to high speed ring armatures, and in Table X. the data for slow speed ring armatures are compiled.

TABLE VIII.—SPEEDS AND DIAMETERS OF DRUM ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N.	Conductor velocity in feet p. sec., S.	Body diameter in inches, d_a.
.1	3,000	25	1¾
.25	2,700	30	2¼
.5	2,400	32	2¾
1	2,200	34	3¼
2	2,000	36	3¾
3	1,900	40	4½
5	1,800	45	5¼
10	1,700	50	6
15	1,600	50	6¾
20	1,500	50	7½
25	1,350	50	8¼
30	1,200	50	9
50	1,050	50	10½
75	900	50	12½
100	750	50	15
150	600	50	18½
200	500	50	22½
300	400	50	28

TABLE IX.—SPEEDS AND DIAMETERS OF HIGH SPEED RING ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N.	Conductor velocity in feet per sec., S.	Body diameter, in inches, d_a.
.1	2,600	50	4
.25	2,400	55	5
.5	2,200	60	6
1	2,000	65	7
2.5	1,700	70	9
5	1,500	75	11
10	1,250	80	14
25	1,000	80	18
50	800	85	24
100	600	85	32
200	500	88	40
300	450	90	46
400	400	92	52
6 00	350	95	62
800	300	95	72
1,000	250	95	87
1,500	225	100	102
2,000	200	100	115

TABLE X.—SPEEDS AND DIAMETERS OF SLOW SPEED RING ARMATURES.

Capacity in kilowatts.	Speed, in revs. per min., N.	Conductor velocity in feet per sec., S.	Body diameter, in inches, d_a.
2.5	400	25	14
5	350	26	17
10	300	28	21
25	250	30	27
50	200	32	36
100	175	35	46
200	150	40	60
300	125	42	78
400	100	44	100
600	90	45	115
800	80	45	129
1,000	75	45	138
1,500	70	45	148
2,000	65	45	158

(To be continued.)

An Unpatented Improvement in the Magneto Telephone.

BY C. E. GIFFORD.

Mr. Ford's experiment, recorded in The Electrical World of May 5, is certainly of interest, but if he will refer again to my article of March 31 he will see that the closed secondary circuit, in the form of a metallic case with soldered joints, is recommended simply for overcoming self-induction—not induction from outside sources. If properly made, such a case will be found very efficient for the intended purpose.

The Bell people have recently placed upon the market a bipolar receiver, in which the coils are wound on solid metallic bobbins, or at least the heads are solid. These bobbins, whether designedly or not, have an action of the same kind as that of the exterior metallic case under discussion.

"Industries and Iron."

It appears that the English journal, "Industries and Iron," has changed hands, having been bought by the proprietors and publishers of "The Laundry News" and "Sugar."

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING

ELEC. WORLD, N.Y.

ELECTRO-PHYSICS.

Bands in Geissler Tubes.—An article by Mr. Gulstein, from the "Wied. Ann.," volume 51, page 62, is abstracted in the "Elek. Zeit.," April 26; he shows that the three bands or layers in the cathode light in Geissler tubes are really three entirely different kinds of rays, having different properties and capable of being separated.

Induction and Inertia.—In the "Elek. Zeit.," April 26, Mr. Baumgardt shows that the analogy between self-induction and inertia is not only correct quantitatively but qualitatively also; he gives the theory and illustrates it with an apparatus made of a pivoted bar magnet, containing a flywheel in its centre, a strong current being passed through it from one end up to the flywheel and a galvanometer being placed in circuit between the other end and the middle contact, thus including the flywheel.

Electrical Interference Phenomenon.—A Royal Society paper by Mr. Barton on "An Electrical Interference Phenomenon Somewhat Analogous to Newton's Rings, but Exhibited by Waves along Wires," is abstracted briefly in the Lond. "Elec. Rev.," May 4.

Theory of Electric and Magnetic Phenomena.—A mathematical article by Mr. Ebert from "Wied. Ann.," volume 52, No. 2, is abstracted in "La Lum. Elec.," April 28.

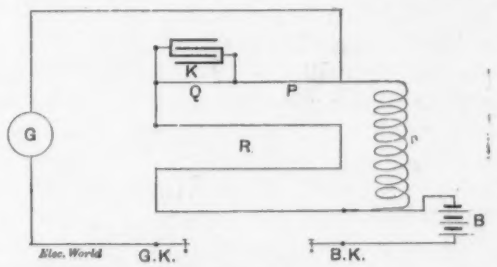
MAGNETISM.

Magnetic Qualities of Iron.—The paper by Prof. Ewing and Miss Klaassen is continued in the Lond. "Elec. Eng.," May 4; a large number of hysteresis diagrams are given as determined by the magnetic curve tracer; in one case the cycles were produced slowly and in another comparatively fast, at the rate of 3 1-2 per second, in which case the rounded corners and increased wideness of the curves are noticeable, and the increased areas show that more work is being done, an effect probably due in great part to Foucault currents; the main part of the circuit was well laminated, but there were thick, solid pole pieces. Some of the curves were recorded by tracing the luminous line with a lead pencil and in others they were photographed; the latter gave good evidence of the constancy with which the movement repeats itself. In another test a small loop was superposed on a main cycle and also on a magnetization curve starting from zero, taken after the metal had been reduced to neutrality, showing the feature that in magnetizing from the neutral state the curve crosses the rising limb of the cyclic curve, which is in agreement with the fact that the extremity of one cyclic curve projects beyond the rising limb of a higher cycle; in another similar test with hard steel this magnetizing curve passes through the extreme points of the several cyclic curves which overlap one another. Another set of curves shows a study in superposed magnetizations in soft iron, there being a constant and a periodic magnetization at the same time; the experiments show that the reversal of a given magnetizing current produces less and less change as the total magnetism is increased, also that a periodic change, in addition to a constant one, does not immediately produce cyclic effects and that during the accommodation period the mean value of the magnetism is rising, a consequence of the molecular shaking which is involved in the process of reversal.

Magnetism of Manganin.—Sir David Salomons calls attention in the Lond. "Elec. Rev.," April 20, to the fact that manganin may be regarded as non-magnetic, but that the filings are as magnetic as iron, a fact which may not generally be known; he suggests that fine manganin wire may possess magnetic qualities. In the issue of April 27, the makers of manganin state that they have repeated the test, but find a complete absence of magnetism; they suggest that possibly the other samples were extremely hard and might therefore have removed some particles of steel from the file, which would account for the observation. In a further communication in the issue of May 4, Sir David Salomons states that it could not have been the steel from the file, because the piece was entirely reduced to powder and the whole of this powder proved to be magnetic.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring Coefficients of Induction.—In the Lond. "Elec.," May 4, Mr. Russell describes two methods for measuring coefficients of self and mutual induction which are convenient in practice, as they do not necessitate a rearrangement of the apparatus for the two measurements. The first, which is capable of giving very accurate results, is shown in the accompanying diagram, consisting of a Wheatstone bridge



MEASURING COEFFICIENTS OF INDUCTION.

(in the form of a British post-office box), a mirror galvanometer and a condenser, which is preferably subdivided; r is the coil to be measured and Q, P and R the resistances of the various arms of the bridge, K being the condenser. First measure the resistance, r, of the coil; if the galvanometer key is pressed down before the battery key there will be a throw of the needle, and if the battery key be opened while the galvanometer key is down, there will be a throw in the opposite direction; if the resistance Q be shunted with the condenser K, these throws will be smaller; use two dif-

ierent values of the condenser, one giving a deflection to the right and the other to the left, and find from the two deflections by the usual geometric construction (or by proportion), the value of the condenser which would give no throw, then L, the coefficient of self-induction, will be equal to this value of the condenser multiplied by Q, by r and by 10^{-6}, the result being in henrys, the condenser value being in microfarads and the resistances in ohms. For measuring mutual induction between two coils let L and N be the coefficients of self-induction and M that of mutual induction; then if the two coils be connected in series the mutual inductive voltage on each coil acts in the same way as the self-induction voltage, and if measured when so connected the total coefficient $A = L + N + 2M$; if B is the result when the terminals of one coil be reversed, then $B = L + N - 2M$, and therefore $M = 1\text{-}4\ (A - B)$. The formulas are also given when the two coils are connected in parallel. This method gives correct values even when the coils are wound on brass cores or if there are closed circuits near them. The second method is not quite so accurate, as it assumes the harmonic law, but, on the other hand, requires only an ordinary alternating current voltmeter and ammeter; measure the voltage V and the current A with a direct current, and the voltage v with an alternating current of the same amperage; construct a right-angled triangle of which the voltage V forms the vertical side and v the hypotenuse, then the length of the third side divided by 2π nA is the coefficient of self-induction in henrys, when n is the frequency. For measuring mutual induction connect the two coils in the two different ways described above, make these same measurements and lay off the same triangles, which will have the vertical side in common and different hypotenuses; the difference between the lengths of the third sides of these two triangles divided by 8π nA will give the mutual induction in henrys; the method fails when the mutual induction is very small compared with the sum of the self-inductions, also when any closed circuits or masses of non-magnetic metal are near the coils. In conclusion, he states that it is very difficult to calculate the coefficients from the geometric dimensions of the coils, and as a general rule the formulas given in pocket-books are only rough approximations and are not safe to use unless one understands them perfectly.

Electrostatic Error.—Mr. Mather, in the Lond. "Elec.," April 27, gives a number of cases showing that the error produced by electrification of station instruments is a very important factor; he has produced a deflection of 80 volts in a 100-volt instrument by a single stroke of his finger across the glass.

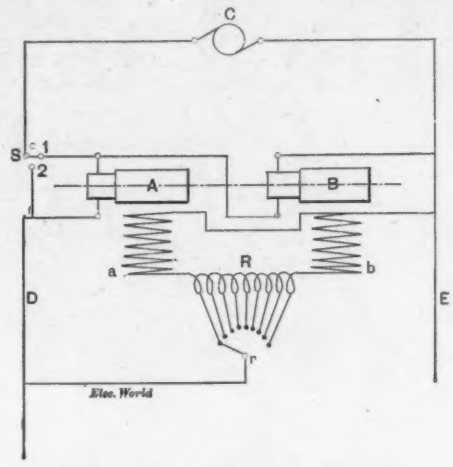
Clark Standard Cell.—Further information about Mr. Kahle's paper is given in the Lond. "Elec. Eng.," April 27; he claims that the variation in the E. M. F. from the normal value can, with little difficulty, be reduced to 0.0001 volt, based on observations covering 1 1-2 years; the temperature coefficient between 10 and 30 degrees (presumably centigrade) was found to be — 0.000814 — 0.000007 (t — 15).

Meters.—The Schmehlik meter is described and illustrated in the "Elek. Anz.," April 15; the readings of the volts and the amperes are recorded on a strip of paper. The Fegs & Lorwa meter is illustrated and described in "La Lum. Elec.," April 21; it consists of an electro-dynamometer and electric clock for measuring and registering the deflections of the pointer. The conclusion of Mr. Wilson's paper on meters, together with the discussion, is given in the Lond. "Elec. Eng.," April 27.

Lightning Indicators.—See abstract under "Magnetic Property of a Static Discharge."

DYNAMOS AND MOTORS.

Variable Speed Motors.—An alternative method to Mr. Leonard's system is described in the Lond. "Elec. Rev.," May 4, by Mr. Boult; it is shown in the accompanying diagram in which C is the motor and A and B the motor-generator, D and E being the line and R a resistance connected to the shunt field windings a and b, which are in multiple arc as



VARIABLE SPEED MOTORS.

shown, and S the main switch; for starting C the switch r is put into the position shown, so that a is fully excited and b feebly excited, the switch S being placed as shown; the main current in passing through A loses voltage, say 460 out of 500 volts, and continues through C to E, while B is driven as a generator by A and supplies a low pressure quantity current to C; as the speed of C is to be increased the switch r is moved to the right. For long runs without stops C is run directly from the mains; as A and B act in parallel to supply current to C, they need not be as large as in Mr. Lenard's arrangement.

The H. Ward Leonard system is also described in the London "Electrical Review" of April 27, where it is also discussed editorially, belief being expressed that the weak point lies in the fact that the efficiency of the working depends on the intelligent care of the motorman; it is also discussed in a communication in the same issue.

Variable Speed Motors.—In the "Elek. Zeit.," April 19, Mr. Baumgardt describes the following system to be used in factories and other like places where electric motors are required to run at greatly differing speeds. Two generators are used and are connected in series, one of 100 volts and the other of 50 volts, a wire being connected to their junction, thus making a three-wire system; the field and armature circuits of the shunt motors may then be connected variously to these three wires, producing a number of different combinations, resulting in different speeds; besides these combinations, resistances may be inserted in the field, thus producing intermediate speeds; by such a combination the relation of the lowest to the highest speed will be as 1 to 9; the theory is given and deductions made from it; the cost of the line wire is worked out and it is found that for variations of from 1 to 10 the copper required for the line is about twice as great as in the two-wire system of the same total voltage and for the same loss of energy, but as the cost of the wire in such an installation is a small part of the total, this factor is not of much importance.

Dynamo.—The novel shaped dynamo mentioned in the Digest May 12 (under Designing Dynamo Magnets) is described and illustrated in the Lond. "Elec. Eng.," May 4.

ARC AND INCANDESCENT LIGHTS.

Heavy Gases in Incandescent Lamps.—The Lond. "Elec. Rev.," May 4, abstracts Prof. Anthony's Institute paper, but emphatically maintains that, contrary to Prof. Anthony and other authorities, the carbon molecules do travel in straight lines and that shadows on the carbon deposits do occur in certain incandescent lamps where the conditions for the production are favorable.

Leading-in Wires.—According to "La Lum. Elec.," April

28, it has recently been found that an alloy of 95 parts of tin and five parts of copper may be fused to glass and will hold with great tenacity; the copper is added to melted tin; the melting point is about 300 degrees C.; by the addition of a little zinc or lead it may be made more or less soft and fusible; nothing is said about its expansion.

Small Arc Lights.—In "L'Ind. Elec.," April 25, Mr. Claude discusses the competition which electric light has to fear, calling attention to the more extended use of petroleum and concluding that in view of the fact that the solution of the problem of the cold light is still distant, the best direction of development of cheap lighting is the introduction of small arc lights to replace incandescent lights as much as possible; he mentions successful lamps of 1.5 amperes, or a total of 75 watts; also the use of reflecting diffusers as distinguished from semi-opaque globes; he encourages inventors to give their attention to small arc lights.

TRANSMISSION OF POWER.

Lauffen-Frankfort Transmission Plant.—The official report of the tests of this plant is abstracted in the "Elek. Zeit.," April 26; the results are as follows: The energy delivered by the second set of transformers averaged 114 h. p., with a mean voltage of 64.3 and a mean current of 440 amperes in each of the three branches, and the average total efficiency from the shaft of the dynamo to the secondary binding posts of the second set of transformers was 74.4 per cent.; experiments were made showing that the effect of the weather on the efficiency of such an installation is probably quite negligible; the efficiency of the dynamo at full load was found to be 95.4 per cent.; the efficiency of the transmission was tested by measuring the low tension current at the generator and at the distant end; the efficiency of the transformer at 100 kilowatts was 96 per cent., the maximum efficiency at which the iron and copper losses are equal was 96.1 per cent.; from half load to full load the efficiency varied from 95.7 per cent. to 96.1 and back to 96.0 per cent.; the mean efficiency of the whole transmission was 73.5 per cent., the total distance was 102 miles, the high tension voltage was 8,500 to 7,500 volts; the lowest efficiency of the whole system was 68.5 per cent. and the highest 72.5 per cent.; the only loss in the line was that due to its resistance, that is, to the C^2 R loss; theoretical researches have shown that the influence of the capacity on the efficiency of such bare air lines for alternating currents of 30 to 40 to 50 periods is so slight that it may be treated as a very insignificant matter in the designing of such transmissions; in conclusion, it is stated that the electrical transmission at that voltage over air lines insulated on porcelain insulators with oil, for distances of more than 60 miles, is just as regular and reliable as with alternating currents of lower voltage and shorter lines. (Preliminary tests of this plant, in which the figures are given in greater detail, were described in The Electrical World July 2, 1892, page 8.)

Transmissions to Great Distances.—The "Revue de l'Electricite," March 31, contains an article on the cost of different forms of transmissions for great distances.

Series Transmission.—A translation of the paper by Mr. Schultz, mentioned in the Digest April 14, is given in an abstract in the Lond. "Elec. Eng.," May 4.

ELECTRIC RAILWAYS.

Heilmann Locomotive.—In a correspondence to the Lond. "Elec. Rev.," May 4, Mr. Sayers states that by using his winding there is no difficulty in constructing a generator to run without sparking at one-tenth its normal field, the speed and current being normal; he suggests that there would be none of the losses mentioned in a previous criticism in starting up the Heilmann locomotive if both generator and motor were series wound and permanently connected, the locomotive being started and stopped by the engine; the maximum torque would be applied at all speeds, and there would be little or no trouble with commutators, even with an ordinary type of machine.

Combination Trolley and Accumulator Line.—According to "La Lum. Elec.," April 28, a line has been recently started in Sydney, Australia, in which, besides the overhead line, there are accumulators on the cars which are used at starting on grades; 40 to 50 h. p. can be developed by the accumulators; this combination increases the efficient working at the power station.

Accumulator Line.—According to the "Elek. Zeit.," April 26, a street railway in Berlin, to be completed in five or six weeks, is to be run with accumulators; no further information is given.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Consumption of Energy by Different Consumers.—In the paper by Mr. Hordern in Lond. "Lightning," April 19, he gives diagrams for a period of four quarters for each of different classes of consumers of the Westminster station in London; it was found that the difference of consumption of individuals in each class was much greater than that between the sections of the class, for which reason it becomes very difficult to forecast a new consumer's bill.

Lighting in Berlin.—The Lond. "Elec. Eng.," April 27, gives the kilowatt hours consumed since the year 1885 under the headings of "Private Lighting," "Street Lighting" and "Motors," from June, 1892, to June, 1893. These figures for 1893 are about 5,000,000, 22,000 and 238,000 kilowatt hours; there are 238 motors, representing a total of 785 h. p.; the net profit on last year's working was about $250,000.

WIRES, WIRING AND CONDUITS.

Networks of Conductors.—In the "Elek. Zeit.," April 26, Mr. Muellendorff publishes an additional article to his paper mentioned in the Digest March 3.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Balloon Signaling.—The Lond. "Elec. Rev.," May 4, gives an illustrated description of the Bruce signaling balloon, mentioned before in these columns, in which a vertical row of six incandescent lamps is suspended in the inside of a semi-transparent captive balloon, 18 feet in diameter and having a capacity of 3,200 cubic feet; the lamps are of 16 c. p. and 55 volts, having spherical bulbs and thinner carbon filaments in order to avoid the afterglow; the signaling is done by means of a key having contacts of carbon; in an experiment the signals were visible at a distance of 16 miles; the balloon is the one constructed for the Italian Government.

Duplexing.—In a communication to the Lond. "Elec. Rev.," May 4, Mr. Bailey points out a "most striking point of incorrectness" of a statement made by Lord Kelvin and Prof. Bottomley, in the recent litigation, that where condensers are used in both arms of the bridge, the sum of the resistances used in combination in the arms of the bridge must remain constant.

ELECTRO-CHEMISTRY.

Purification of Sugar.—"La Lum. Elec.," April 21, abstracts a paper by Dr. Bersh describing the Schollmeyer-Behne and Dammeyer system (see Digest May 13, July 15, Dec. 9, 1893, and March 24, 1894), as applied in the Hoym factory in Germany. In addition to what has already been stated in these columns, the following may be of interest: Each of the two compartments has a capacity of 1,500 litres, each charge being treated for a period of ten minutes by a current of 50 or 60 amperes, being equal to a current density of 7 to 14 amperes per square metre of electrode (presumably of the zinc electrode); there are 7 electrodes of sheet zinc, having a surface (total?) of 6 square metres; the electrolysis produces a gelatinous material, which is difficult to filter, to obviate which a small quantity of chalk is added to the liquor; 1 per cent. of chalk will, in this way, produce better

results than 3 to 4 per cent. in the ordinary process; during the last year considerable trouble was experienced at this factory with a formation of froth in the ordinary process, due to the beets being of poor quality, but with the electrolytic process no froth is produced; there is also less destruction of the sugar. He states that in eight days the cost of the installation was paid for by the results obtained; the quantity of steam for generating the electricity is said to be of no importance; with 6 volts only 1-2 electrical horse power is required.

Pollak Accumulator.—According to a test recently made in an installation in Frankfort, after running a year and a half, one battery had a capacity of 562.5 ampere hours, an efficiency of 97.5 per cent. in ampere hours and 83.6 per cent. in watt hours; in a second battery with a capacity of 725 ampere hours the efficiencies were 97.1 per cent. and 81.9 per cent. respectively; the capacities were respectively 25 and 61.1 per cent. greater than what was guaranteed; it is stated that since their installation no repairing whatever was necessary.

Accumulator.—Mr. Gruenwald makes an active mass by mixing pulverized lead with linseed oil and borate of manganese; electrolysis changes the oil into a resinous substance, which forms the binding material.

Aluminium.—According to "La Lum. Elec.," April 28, the installation to be established at La Praz will use 3,000 h. p., with 15,000 still available, and will produce three tons a day; it is questioned whether at the low price there will be sufficient demand for this quantity of material. It states that in the south of France bauxite of great purity is found, from which it is thought that aluminium at 4 francs per kilogram (37 cents per pound) may be made with the electric process.

MISCELLANEOUS.

Heating by Contact with an Electrolyte.—In "La Lum. Elec.," April 21, Mr. Hoho discusses this phenomenon at some length; in the phenomenon referred to a strong current is passed through a piece of metal immersed in an electrolyte, which causes the metal to be heated rapidly (see Digest April 29, July 8, Aug. 5 and 12, Nov. 11, Dec. 9, also May 6, 1893; March 17, April 7 and 14, 1894, and The Electrical World June 10 and July 15, 1893). He states that the phenomenon was described a long time ago by quite a number of physicists and gives references to their publications, dating back as far as 1841; he describes the researches of Plante referring to this phenomenon. In the early part of 1890 Messrs. Hoho and Legrange made exhaustive experiments, publishing their researches in the Bulletin of the Royal Belgian Academy in 1891, No. 9-10. He then describes in detail what takes place when the E. M. F. increases; first there is electrolysis, and after an increase in the voltage a crackling sound is produced and the liquid seems to boil; at still higher voltages luminous points appear on the electrode; after further increase these luminous points become more numerous, forming finally a luminous sheath, the color of which depends on the nature of the electrode, the electrolyte and the voltage, and the current, which before then was very irregular, now becomes steady and reduced in quantity; with a further increase greater heat is produced; the phenomenon manifests itself better at the negative electrode, the sheath at the positive electrode being less stable; it takes place with all conducting liquids and conductors, the voltage, however, being different for different materials; the nature of the electrode seems to have no appreciable influence on the E. M. F. necessary to produce the first appearance of the phenomenon, but it does seem to have an influence on its maintenance; it is greater for the negative than for the positive electrode; the tendency of the current is to remain constant for increasing voltages; the surface of the anode is a very important factor and the current increases almost in proportion to this surface; the nature and form of the electrode have some influence; they found the same phenomenon with alternating currents, but with certain marked differences. He then discusses at some length the extended researches of Koch and Wueller published in 1890-'92.

The paper is concluded in "La Lum. Elec.," April 28; after summarizing his previous papers and giving references to them, he discusses the paper of Mr. Neher in The Electrical World, July 15, 1893, in which it is stated that the phenomenon does not take place if the metal is immersed before the circuit is closed; to this Mr. Hoho replies that if a slightly higher voltage had been used the phenomenon would have taken place; he shows in a table of results the effects of the temperature on the bath, from which it appears that with a constant E. M. F. the current diminishes as the temperature increases, and at near the boiling point the phenomenon no longer takes place. When carbonate of potassium is dissolved in glycerine he finds that less energy is required to form this luminous sheath, and the stability is greater than with water, the sheath is thicker, quieter and disengages less vapor; a given quantity of energy transformed into heat vaporizes a larger quantity of glycerine than of water and the resistance of the sheath will be greater; he discusses at some length the explanation of the phenomenon and believes that there is no question that it is simply due to the fact that this sheath introduces into the circuit a very great resistance.

In an article on this process by Mr. Ehrenfest in the "Elec. Tech.," April 15, he states that it has been found that the cost of welding by this system is half that of the ordinary forge system.

Electric Balloon.—"La Lum. Elec.," April 21, gives some further information regarding the electrically driven balloon to be operated at the Antwerp Exhibition (mentioned in the Digest Jan. 27). The oblong shape has been adopted, the length from point to point is 81.5 metres, the diameter of the central part 17.5 metres and the volume 14,000 cubic metres; with ordinary lighting gas an ascensional force of 0,800 kilograms is expected, enabling 25 to 30 passengers to be carried; the cage will be divided into three parts, the upper one for the navigator, the next for the passengers and the lower one for the machinery; the electric motor will have 125 h. p. driving a propeller 8 metres in diameter with four wings; a speed of 40 kilometres (24 miles) per hour is expected, the total distance being 1.8 miles; the electric cables are wound on a drum with special braking apparatus to allow for automatic winding and unwinding, according to the requirements; the trolley wire is composed of a cable 25 millimetres (about one inch) in diameter, made of galvanized steel wire, carried on an overhead structure 30 metres (100 feet) in height; the generator will consist of two gas engines, each of 200 h. p., supplied by power gas made specially for them, and two triphase current dynamos. (The abstract is taken from the "Revue Industrielle," the date of which is not given; as it will be seen, it is rather incomplete and probably some statements are not correct.)

Aerial navigation is discussed by Mr. Schoelfleuthner in the "Elec. Tech.," April 15, in which he concludes that a system like the above is the easiest solution of the problem.

The flying machine of Prof. Wellner, mentioned in the Digest Feb. 24, which is about being constructed in Austria, is described and illustrated in a paper by Mr. Bethuys in "Cosmos," March 31; peculiarly shaped, curved, paddle wheels are used, two of them being located above and on the sides of the balloon proper.

Mechanical Application of Electricity.—"La Lum. Elec." contains a serial by Mr. Richard (mentioned several times before in these columns) containing short descriptions, accompanied by a number of well executed illustrations of various mechanical applications of electricity, taken apparently from patent specifications.

Suggestions for Transit Systems.—II.

BY S. D. MOTT.

The street system shown in the drawing is what may be called a sub-surface or sub-trolley line. It is not so very much of a departure from the overhead trolley system, the primary feature, of popular moment, being an absence on the street of poles and lines, and the features of practical moment being the ease and cheapness of converting the present cable roads into electric lines, and also the feature of depressing to

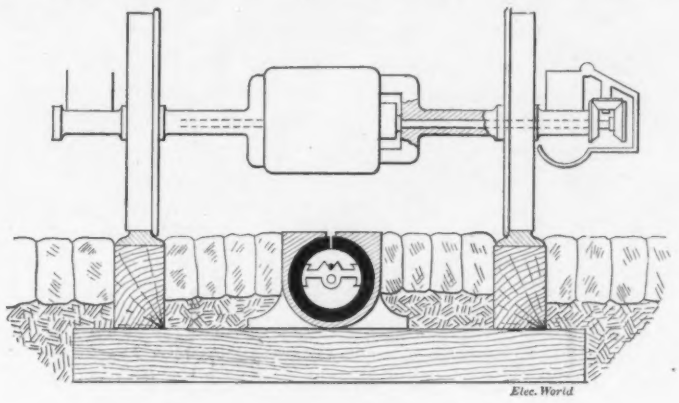


FIG. I.

a sub-trolley line the electric suburban roads at points on the line where for any reason overhead construction is prohibited or undesirable. The trolley wire is carried down a supporting pole and continued, for a distance, it may be, sub-surface. The sub-trolley system (Fig. 2) consists of a trolley wire or cable of small dimensions—the size depending upon the E. M. F.—raised out of a conduit slot and travelling above the surface of the ground for about four feet underneath the cars as it progresses, there making electric contact to motors, thence trailing back into conduit as the car recedes.

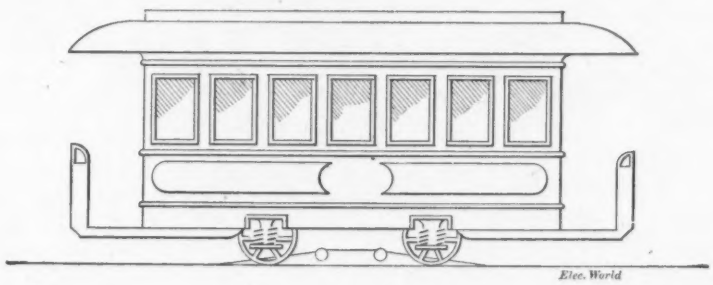


FIG. 2.

It may be a single circuit, using the ground as return (Fig 1), or it may be operated on metallic circuit (Fig. 3). This line will take curves and switches with the same facility as overhead trolleys, and with greater facility and less expense than the cable systems. With ordinary electric roads the single trolley wire frequently carries current for all cars on the line. It will be observed here that the working conductor carries current for and to one car, the feeding conductor (Fig. 5) energizing the working conductor at all points;

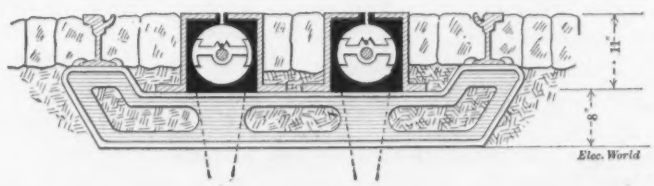


FIG. 3.

hence the working conductor may be smaller than ordinary trolley wires and should it break the road is still operative at all points except at the break. If it be desired that the sub-trolley conductor be insulated, the use of an alternating motor is required for propelling the car, together with a converter of especial construction.

Figs. 1 and 3 are insulated conduits; this conduit may be made of any suitable insulating material, such as concrete, cement, asphaltum, fireclay, or vitreous substances, such as earthenware waterpipe. They may be filled with mud and water without leaking a perceptible current if properly constructed. Arrangements for flushing the conduit may be made by equipping a car for this purpose. Unlike cable

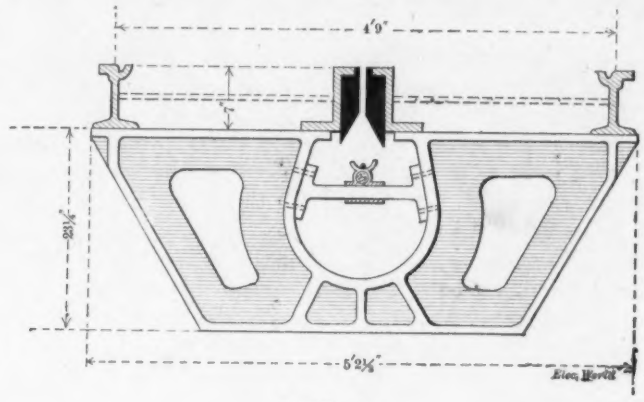


FIG. 4.

roads, one car may run faster than another and in either direction, and there are no rigid sub-surface connections preventing the moving of cars on any but cable roads.

The excavation for road, as here shown, is 19 inches, as compared with 30 1-4 inches for cable road construction.

In view of the desire of the cable companies in some instances to substitute electric traction for their present systems, the inexpensive adaptation of this system to such roads, utilizing the cable and conduit already down is shown in Figs. 4 and 5. The change can be made at minimum cost and without necessarily disturbing the street pavements.

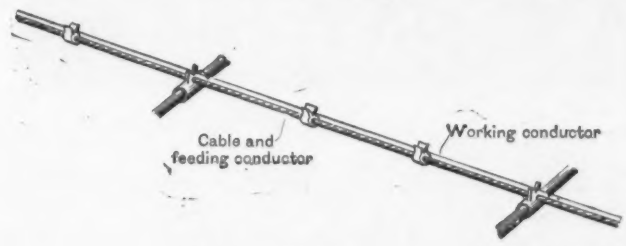


FIG. 5.

The cable (Fig. 5) is mounted upon and supported by (ground glass) insulators (coated, for instance, with paraffine), and is used as a feeding conductor energizing the working, or trolley, wire.

A "Bitter-Sweet" Compliment.

It is refreshing to see that sometimes the London electrical journals find something good and original in America, even though they cannot resist adding a bitter remark. A recent issue of a London contemporary, in speaking of the office buildings of the American type, states "Would we had a few of them in London. The American office building is the one (!) item in America wherein Americans might safely claim absolute pre-eminence, and it is the one item they never do brag about."

A Westward Movement of the Centre of Gravity of the Electrical Industry.

In a recent issue of a German electrical journal every one of the five leading illustrated articles are of American origin, and in the very next issue three out of five are American.

The New Telephone Exchange at Atlanta, Ga.

The Southern Bell Telephone and Telegraph Company has in operation in Atlanta, Ga., the most modern and complete telephone exchange and wiring system in the entire South, and one of the most complete in the country. Realizing the growing commercial importance of Atlanta, the company decided over a year and a half ago to erect a telephone exchange building and underground cable system for that city. The work was begun in January, 1893, and everything was completed and in operation by January of the present year.

The new telephone building, as shown in the cut, is a handsome three-story structure of stone and terra cotta, covering an area 3c feet by 107 feet. It has a large and commodious basement, containing a storage battery room, furnace room, and general storage and district supply rooms At the front, extending far out under the street, is the office manhole, connecting with a side passage forming the cable runway. The office manhole, from which the cable runs, is a cement lined, vaulted roof chamber, 8 feet wide by 44 in length and 9 feet high, and is ventilated very efficiently by two pipes, one running from the surface of the ground to near the bottom of the chamber to supply fresh air, the

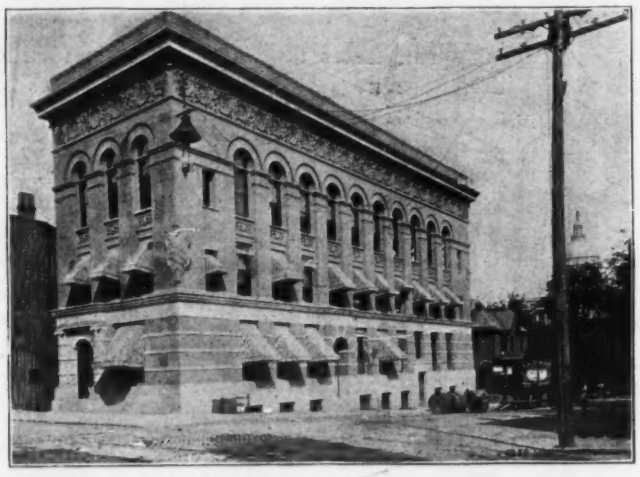


FIG. 1.—ATLANTA TELEPHONE EXCHANGE.

other connecting the top of the chamber with the top of the building, and carrying off all foul air and gases. The difference in air pressure between the chamber and the top of the building causes a continuous flow of air. The cable runway is 4 1-2 by 57 by 11.

The first or ground floor contains a handsome set of offices in the front. In the rear are the inspectors' rooms, distributing rooms for wires and district supply stock room.

On the second floor, front, are the offices of the district superintendent, Mr. John D. Easterlin, and back of them the office of the electrician, Mr. James A. Wotton, adjoining the shop rooms. The shop is the largest in the Southern territory, and is equipped with all the machinery and tools for manufacturing and electro-plating the special apparatus necessary for telephone work. It is operated by two 3-h. p. motors, obtaining current from the city lighting company. In the laboratory part of the shop are to be found the necessary electric and chemical apparatus for experimental work and testing.

The third floor is given up entirely to the operators and operating room. The front rooms of this floor are fitted up most comfortably as parlor, dressing room and toilet and bath rooms for the girl operators, and adjoining them is a kitchen, with gas stove and utensils for use at meal time. The operating room in the rear is large and well ventilated and lighted.

The switchboard is a bridged terminal metallic circuit multiple switchboard on the Law system, 100 feet in length, of a capacity of 4,000 metallic circuits, and wired at present for 2,000 circuits. This board was built in Atlanta, and its arrangement is of special interest, differing as it does from that of almost all other telephone exchanges. It is equipped with listening and ringing keys to facilitate connection, and

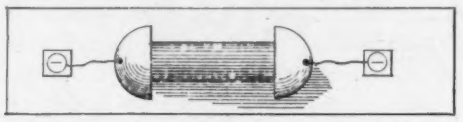


FIG. 2.—DISRUPTIVE DEVICE.

uses the current furnished by a storage battery for switchboard transmitters. The alternating current for the call-bell working is furnished by an Eickemeyer dynamo, which also supplies a direct current for charging storage batteries for emergency use. Should the dynamo be shut down, the storage batteries are automatically thrown into circuit and operate the call-bell circuit through a pole changer.

A special feature is the device adopted for the "busy test," indicating when a subscriber's line is busy. Owing to the electric railways throughout the city, the ordinary device would give the "busy test" clicking sound in the earphone when the line was not in use. To obviate this difficulty a relay circuit was employed, which the earth railway currents are not strong enough to operate, but which is readily operated by the battery current.

The cables enter through the office manhole and cable runway, and at the end of the runway the cable wires are all connected to Okonite wires, which run to a distributing frame. From the distributing frame each circuit is connected to the lightning arresters, which consist of strips of carbon separated by a sheet of mica.

An interesting and unique feature of the call circuit is the protective device against heavy currents. This is the invention of Electrician Wotton, who holds a patent on it. It is a difficult thing to have a small-capacity fuse act with certainty, and Mr. Wotton, apprecating this, devised a disruptive device, which will act with absolute certainty whenever the current exceeds three-tenths of an ampere. This device is shown in Fig. 2, and consists simply of a small graphite cylinder capped at both ends with brass caps, to which the circuit wires are connected. A small amount of fulminate of mercury is placed in the ends of the graphite cylinder under the caps. On the passing of an excessive current a small explosion occurs, blowing out the graphite and disrupting the circuit.

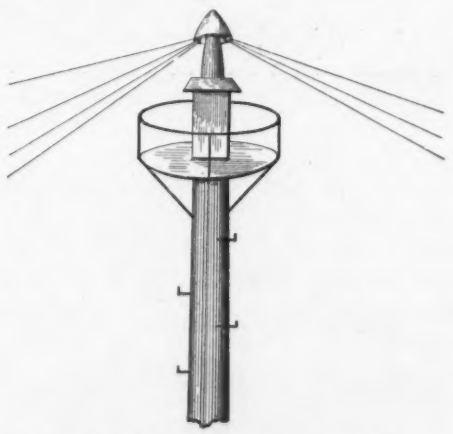


FIG. 3.—DISTRIBUTING POLE.

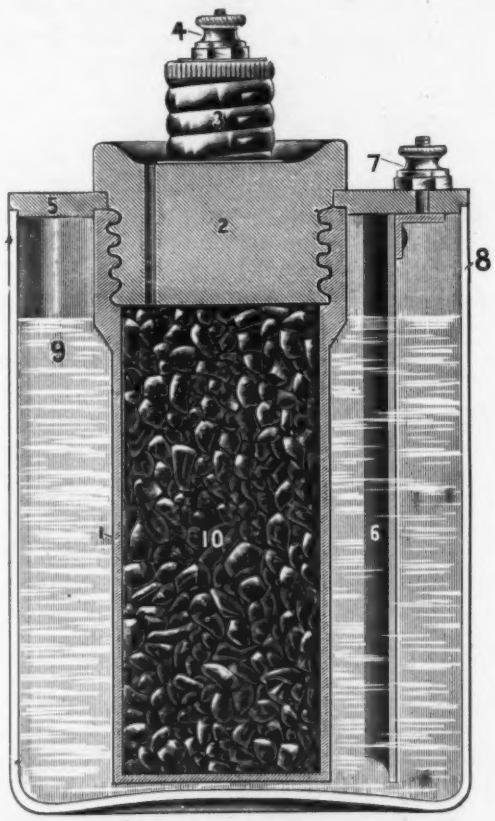
The distributing boxes on the poles throughout the city have similar protective devices for each wire.

For the underground cables 15,000 feet of trench was dug, in which was laid in cement 150,000 feet of three-inch iron cement lined conduits of the National Conduit Com-

pany's make. The conduit starts with forty ducts, sufficient for forty cables, seventeen of which are installed. The cables are paper and lead insulated, of the Standard Underground Cable Company's make, each cable containing 200 wires. The actual length of cable in use is over 150,000 feet. The underground conduits extend a radial distance of about 4,000 feet from the centre of the city, and beyond this distance the wires are carried overhead on poles. The wires are distributed from pole tops in radial fashion, as shown in the cut, 200 arms from each pole. Pine poles are used, 90 feet high, and are set in tar cement.

The Hayden Carbon Porous Cup Cell.

We illustrate herewith a carbon porous cup cell manufactured by the Hayden-Booker Manufacturing Company, 2,140 De Kalb street, St. Louis, which differs in important points from similar cells. Figure 1 is the carbon porous cup, made by a special process which renders it very porous. The walls are but one-quarter inch thick, and the cell attains its full strength immediately it is set up. The cup is screw-threaded at its upper end to receive a carbon screw cap, 2, which is of close-grained carbon, and being a separate piece, is treated so that it cannot absorb moisture, and thus renders corrosion impossible; 3 is a metal screw cap and 5 the jar cover, which is clamped between the carbon screw cover and the carbon cup. This cover is provided with an opening for the zinc, 6, which is clamped to the cover, as shown, though a loose zinc can be used, in which case it or the carbon must have rubber bands to prevent contact between the two. The solution should stand to the shoulder of the carbon cup. The depolarizer is of manganese, which is renewed when exhausted. In the usual carbon porous or clay cup cell where a depolarizer is used, the whole element is worthless when the depolarizer is exhausted, and as the depolarizer does the work, it therefore in time becomes dead. The cup and its cover being indestructible, and not injured by service or time, the only renewal necessary is the filling, which is as simply done with this cell as in renewing the solution.



CARBON POROUS CUP CELL.

A New System of Electric Power Station Construction.

Mr. B. J. Arnold, of Chicago, has designed a system of electric power station construction which, it is claimed, combines the flexibility of the low speed other large engine belted plant with the low first cost of a direct connected or direct belted plant.

The advantages of the new system are summed up as follows: Less cost per kilowatt of plant installed; less cost in operating expenses; less real estate occupied; great flexibility; less depreciation; greater ease in handling than in power plants as heretofore installed.

Referring to Figs. 1 and 2, the system will be described as applied to a plant having a capacity of 2,000 h. p. Engines 1 and 2 are cross compound condensing engines of 1,000 h. p. each, and generators 1 and 2 are of 750 kilowatt each. The armatures of the generators are mounted on hollow cast steel shafts or quills, Cc, running in independent bearings, Pp, so arranged that they are free to revolve independent of either engine and of each other. Through these quills and supported at its centre by a bearing D, extends a steel or wrought iron shaft carrying upon its ends circular cast steel or iron discs, Ff, securely keyed to the shaft.

The illustration shows the engines connected to generators with magnetic clutches which operate as follows: Attached to the end of the engine shafts, Aa, are circular cast iron or cast steel discs, Hh, carrying in recesses copper coils, Oo, which are connected to brushes, Qq, by means of rings, Rr, in such a manner as to permit a current of electricity to be passed through the coils while the discs are in motion. Around the vertical face of discs Hh, near the peripheries, are carried cast steel or cast iron rings, Ii, which are held in position on discs Hh, by means of three gudgeons or bolts equally spaced around the periphery of discs Hh. Rings Ii are normally held against discs Hh by small spiral springs surrounding the gudgeons or pins. Attached to quills Cc are cast iron or cast steel discs, Jj, carrying two coils of copper wire, Mm, Nn, which are connected to brushes Kk so as to allow a current to be passed through the coils when the discs are in motion.

If a current of electricity is passed through the coil M a magnetic field will be created around it which will have a tendency to attract the disc I, overcoming the action of the springs, which normally hold it against the disc H and clasping it securely to the disc I, so that power can be transmitted from one disc to the other disc by friction so long as the current traverses the coil, M. If the engine No. 1 now be set in motion, it will drive generator No. 1 directly connected, and in like manner engine No. 2 can be connected to generator No. 2, thus forming two direct connected power units. The shaft, E, lies in the bearing, D, and is not used except in case it becomes necessary to drive either generator from the opposite engine or both generators from the same engine.

If engine No. 1 and generator No. 2 were disabled, generator No. 1 could be driven from engine No. 2; current would be passed through coil O, thereby attracting disc I, which would set shaft E in motion. Current would also be passed through coil N attracting disc L, which would set the armature of generator No. 1 in motion. Current would then be cut off from the coil, M, allowing the generator No. 2 to come to rest. In a similar manner, if engine No. 2 were disabled, generator No. 2 could be driven direct from engine No. 1, and either generator or both generators are thus available from either engine. It will be seen in Fig 1 that the main shaft of both engines is cut off in the middle and the two parts joined together by positive jaw clutches operated by steam cylinders. Thus, when the load is light the engine and generator No. 1 can be shut down. Cylinder

D of engine No. 2 is cut off by means of a jaw clutch, and no portion of the plant operates except the high-pressure cylinder of engine No. 2 directly connected to generator No. 2. This cylinder can be run condensing and the plant thus economically operated even under these circumstances.

In case of repairs, for example, to the high-pressure cylinder of No. 2, at the same time that full power is demanded of engine No. 1, high-pressure steam may be admitted to the low-pressure cylinder of engine No. 1, which will thus give full power for driving the generators while the high-pressure side of No. 2 is shut down for adjustment.

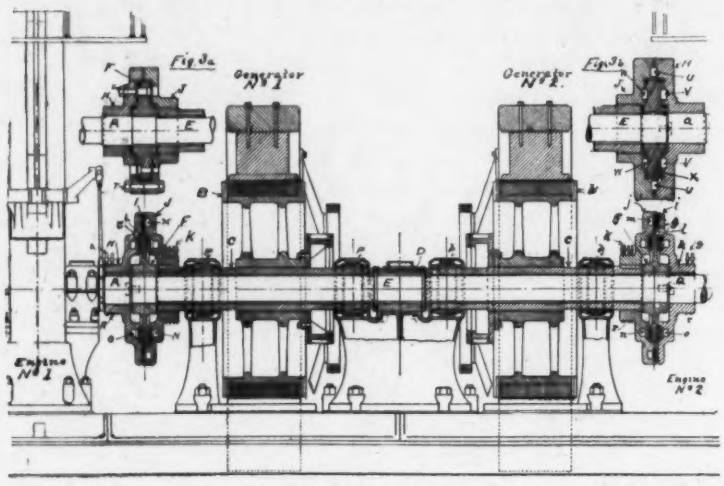


FIG. 2.—NEW SYSTEM OF POWER STATION CONSTRUCTION.

The system also includes a method of electrically starting the generators so as to prevent wear on the rings of the magnetic clutches, the generators being run as motors until their armatures attain the necessary speed. In case that it ever becomes necessary to increase the capacity of a power plant like that described, it can be done by adding generators and engines to the right and left of the two engines shown. It will thus be seen that any generator in such a plant can be started or stopped at will without stopping either engine and without using belts, pulleys or friction clutches, and in addition there are advantages heretofore noted as to reliability, cost, ease of handling and operation.

An Electric Carriage.

The Benz electric carriage was first shown at the late Munish Exposition, and the Emperor William is said to have recently ridden from Maxau to Lauterburg. The trip, a distance of 15 miles, is claimed to have been made in 35 minutes. On his return home the Emperor ordered a very luxurious carriage to be built at once for his private use.

Among the first to recognize the importance of this field in this country was Mr. G. K. Cummings, of Chicago, who has recently finished and put on the streets of that city an electric carriage embodying the latest and best designs for successful commercial operation.

An examination of the accompanying illustration will show that the gearing is positive and direct in action, while the use of the link belt allows a certain flexibility which practice has demonstrated is necessary. The speed is under perfect control by means of the foot pedal actuating a switch under the forward part of the carriage, and the direction of the carriage is so easily controlled by the handwheel that a child can direct it, and the various parts so accessibl eand simple that after a few moments instruction and explanation a novice can operate the vehicle.

The motor is a 2-h. p. series wound 24-volt machine. The end of the armature shaft carries a rawhide pinion engaging with an iron gear on a countershaft directly connected with the rear axle through a link belt. The rear wheels are both driven, but when the vheicle turns a corner or deviates from a straight course, by an ingenious device through a system of hardened steel roller clutches, either driven wheel may move independently of the shaft or the other wheel, so that the one on the outside of the curve will automatically adjust its speed to the distance it has to traverse. This difference of speed of the two driven wheels is considerable, as on the sharpest turn the periphery of the inner wheel covers only one-half the distance traveled by the outer one. The front axle is made of aluminum bronze, is rigid and carries two short supplemental movable axles, to which are attached the front wheels. The movable axles are connected to each other by a pivoted iron bar, so that their action is reciprocal. The inner end of the right-hand one is toothed, engaging with a pinion on the end of the shaft carrying the handwheel.

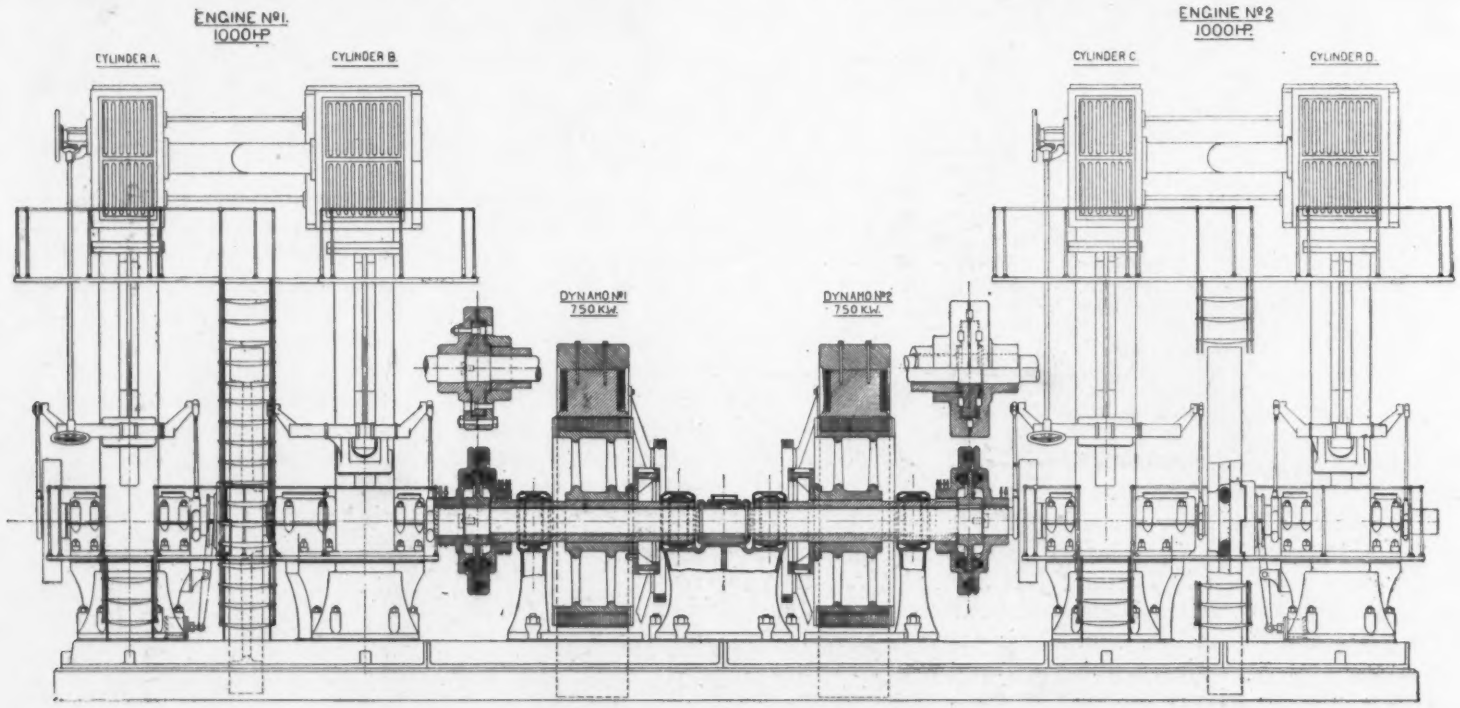
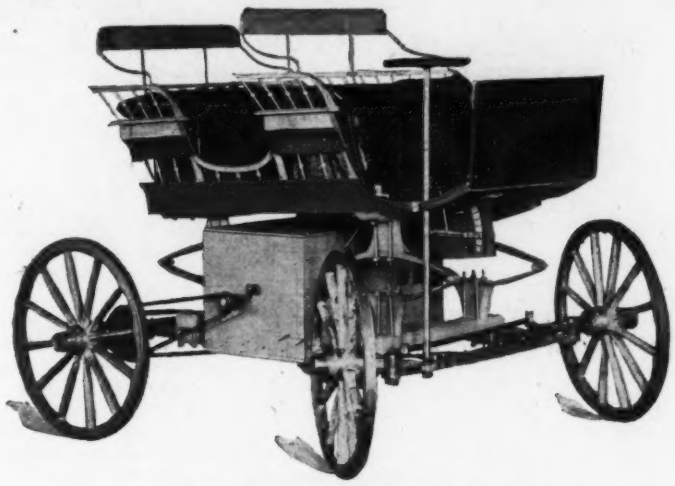


FIG. 1.—SYSTEM OF POWER STATION CONSTRUCTION.

The framework of the running gear is of angle iron, supporting four springs placed longitudinally with the body of the carriage, which has a seating capacity of four people.

The current needed is derived from 200 ampere-hour storage battery cells placed under the seats of the carriage. The brake is a leather lined steel band clutch.

Recent tests of this carriage show that over level city roads



ELECTRIC CARRIAGE.

at a normal speed of ten or twelve miles an hour, a maximum average of from 1 1-4 to 2 electrical horse power is all that is required, the difference in power consumed depending on the state of the roads and the style of paving traversed. The questions of running through the mud, over street car tracks, raised obstructions, such as manhole covers and the like, starting up from ruts and gutter, have been taken up carefully in turn, and through actual operation it has been demonstrated that the vehicle easily overrides such obstacles.

As to cost of operation, taking as a basis a daily run of 50 miles at 10 miles an hour and the average consumption of power at two electrical horse power, at the published rate of charge for current of the Chicago Edison company, the expense would be only $1C per month; this would be cut down to $5 or $6 per month if an average daily trip of 20 to 25 miles be made. This would compare very favorably with a great majority of city vehicles.

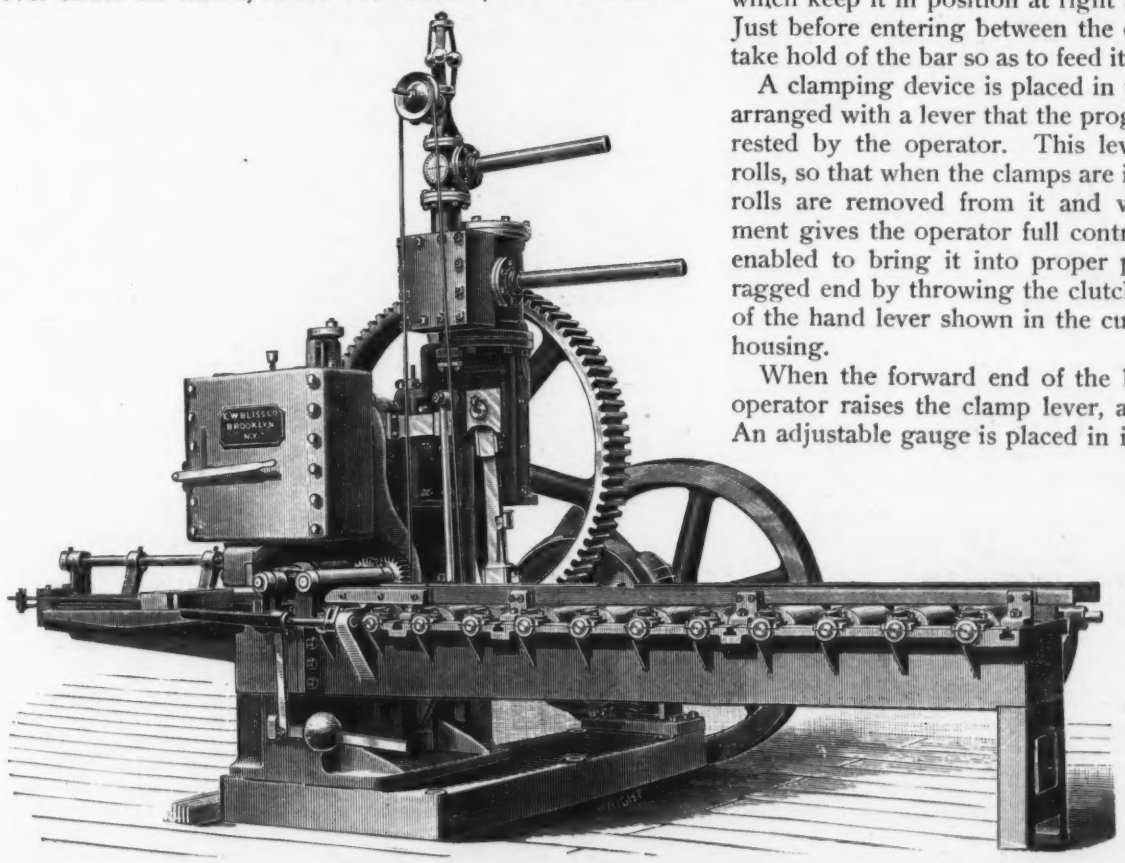
A company is being formed to place a line of these carriages on the market, including six-seated phaetons for use in the different park systems in large cities, and smaller vehicles of three-wheel variety to seat two persons, which may be rented out by the hour.

Automatic Muck Bar Shear.

The method heretofore employed for shearing a muck bar of steel has been to carry the bar to the old-fashioned alligator shear, place the end against a fixed gauge, which determined the length of the pieces, and pass the bar along by hand for the successive cuts. This method not only requires the labor of several men to handle the bar, but calls for considerable skill on the part of the shear man, and unless great care is used, the results are liable to be unsatisfactory. The illustration represents a machine designed by the E. W. Bliss Company for doing this work automatically, thus requiring but one man to do the work, who need not be a skilled shearman. The machine consists of a powerful gate shear, driven directly by an engine. A clutch is attached to the engine shaft, which can be operated either by hand or automatically. To the right of the machine is a carrier composed of a train of rolls driven continuously. The muck bar, coming hot from the rolls, is placed upon these carriers, which propel it toward the cutters between side gauges, which keep it in position at right angles to the shear blades. Just before entering between the cutters a pair of feed rolls take hold of the bar so as to feed it positively.

A clamping device is placed in the path of the bar and so arranged with a lever that the progress of the bar may be arrested by the operator. This lever also controls the feed rolls, so that when the clamps are in contact with the bar, the rolls are removed from it and vice versa. This arrangement gives the operator full control over the bar, and he is enabled to bring it into proper position to square off the ragged end by throwing the clutch into operation by means of the hand lever shown in the cut at the front of the cutter housing.

When the forward end of the bar has been squared, the operator raises the clamp lever, and the bar feeds forward. An adjustable gauge is placed in its path, and upon striking this its progress is arrested and the clutch is automatically thrown into operation, causing the upper shear blade to descend and cut off the first length. As soon as this occurs the piece drops out, the shear blade ascends to its upper position and stops, while the bar again feeds forward, and the operation is repeated until the bar is all cut to lengths. By this system the bars are cut accurately, and as rapidly as they come from the rolls.



AUTOMATIC MUCK BAR SHEAR.

In order to adapt the machine to the practical requirements of mill work, experiments were conducted for some time by the makers at the mills of the Canonsburgh Iron and Steel Company, and this machine is the outcome of these experiments.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, May 19, 1894.

THE ELECTRICAL STOCK MARKET this week has been practically confined to two stocks—General Electric and Westinghouse. Some little interest has been shown here in Western Union, and Boston has devoted some attention to American Bell Telephone, but the dealers in this class of securities have been mostly concerned in the operations of the two first-named stocks.

GENERAL ELECTRIC, as was intimated in the last review of the electrical stock market, continued to be beared all week long. The friends of the property have disappeared. Wall Street is no longer regaled, as it was a few weeks ago, with "official" recitations of the enormous revival of business and the brilliant future of the General Electric Company. There is a rather well grounded opinion held in many Wall Street quarters that insiders know a good deal more about the present pressure on General Electric than is consistent with their relations to the company, officially and otherwise. It is well known that one or two Boston interests, hitherto closely identified with the company by reason of large holdings of stock, have been quietly liquidating their lines. One or two New Yorkers are also not free from suspicion of similar doings, and, while the weakness of the stock was started by the operators on the short side of the market, they have been materially aided by the endeavor of several so-called "inside" interests to get out even around present prices. The success of the bear campaign has been due to a combination of causes, but the operators on the down tack have made good use of their opportunities, and are now firmly entrenched in a position whence it will not be easy work to dislodge them. They are in full control of the manipulation of the stock, and every attempt to rally General Electric is met with persistent offerings of the stock that effectually block any upward movement or even undue show of strength.

WESTINGHOUSE ELECTRIC naturally profits by all that has been said against General Electric. All the comment that comes to light is most favorable. At the annual meeting, held in Pittsburgh this week, where the old board of directors was re-elected by a vote of 113,000 shares, President Westinghouse laid special emphasis in his address on the fact that, since the date of the present annual report, when the outstanding bills payable were $560,982, the latter had been further reduced by collections so that the amount now outstanding was only $380,575. It will thus be noted that the business methods that have been applied to the management of the property are accomplishing most excellent results.

AMERICAN BELL TELEPHONE quotations have not varied much of late. Legislative interference with the company's plans is disappearing, and the company's service is everywhere being improved upon. Some of the sub-companies are about to introduce the Buffalo system of rates as a further bid for popular favor. In the Buffalo system the charges for a telephone are according to the number of telephone calls. Some experimental telephones are to be put into New York residences based on this system, by which beyond, say, 1,000 calls per annum, tolls are to be charged. When a plan of toll service for telephone subscribers has been worked out, it will lead to concentrated action by all the exchanges operating through the American Bell Telephone Company.

WESTERN UNION TELEGRAPH has been somewhat under a cloud. The departure of George Gould for Europe has been a signal for an aggressive bear campaign against all the Gould stocks, and Western Union has not been spared. It is alleged that big inroads have been made upon the company's earnings by the substitution in many quarters of long distance telephones for private telegraph wires. Thus there are now only three or four private telegraph lines between brokers' offices in New York and Chicago, where there were formerly a score. Between New York and Philadelphia, and New York and Boston the telegraph has been discarded altogether in favor of the telephone. Then, too, the pool rooms in this city continue tightly closed, and this big loss to the Western Union continues permanent. None the less the stock does not yield easily because of the large spread of holdings in investors' hands, and their unwillingness to be scared into liquidation.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	10	30
Detroit Electrical Works	10	2	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref	15	15	16
" " " com	15	15	17½
Edison Electric Ill., New York	100	100½	101½
" " " 1sts	—	107¼	107½
Edison Electric Ill., Brooklyn	100	102	103 *
" " " Boston	100	116	117
" " " Chicago	100	130	135
" " " Philadelphia	100	125	127
Edison Electric Light of Europe	—	—	3
" Bonds	—	80	85
" Ore Milling	—	10	11
Fort Wayne Electric	—	3½	4
General Electric Company	100	35⅞	36
" " " deb. 5's	—	88½	89
Interior Conduit and Ins. Co	100	56	57
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	37	38
" " " pref	50	51½	52
Western Union Telegraph	—	82	—
American Bell Telephone	—	190	190½

*Ex. Dividend.

New Incorporations.

THE MOUNT PLEASANT STREET RAILWAY COMPANY, Des Moines, Iowa, has been incorporated by Geo. E. Smith and others.

THE CRESCENT ELECTRIC COMPANY, Chicago, Ill., capital stock $10,000, has been incorporated by Walter H. Adams and others.

THE GILLILAND TELEPHONE COMPANY, Chicago, Ill., capital stock $1,000,000, has been incorporated by Andrew F. Crane and others.

THE PACIFIC STETHOPHONE COMPANY, San Francisco, Cal., has been incorporated, and is to deal in stethophonic and telephonic appliances, etc.

THE COLUMBUS TELEPHONE MANUFACTURING COMPANY, New York, capital stock $100,000, has been incorporated by Edw. S. Wallace and others.

THE BLOCK HEAT AND LIGHT COMPANY, Camden, N. J., capital stock $100,000, has been formed by Samuel H. Robbins and others. It may be addressed.

THE QUINDARE PARK ELECTRIC RAILWAY COMPANY, Kansas City, Kan., capital stock $200,000, has been incorporated by J. P. Moore, C. C. Dail and others.

THE MONONGAHELA MAGNETIC TELEPHONE COMPANY, Monongahela City, Pa., capital stock $3,000, has been incorporated by C. S. Crall, Oliver Scott and others.

THE PITTSBURGH AUTOMATIC LIGHTING COMPANY, Pittsburgh, Pa., capital stock $25,000, has been incorporated. C. H. Cobell and Lawrence Wolfel are interested.

THE CO-OPERATIVE ELECTRIC RAILWAY COMPANY, Chicago, Ill., capital stock $1,000,000 has been formed. Morris S. Evinger, Charles E. Burnap and Isaac T. Dyer are the incorporators

THE INTERSTATE CONSTRUCTION COMPANY, Des Moines, Iowa, capital stock $500,000, has been incorporated by E. I. Rosenfeld and others to construct and operate railway and telegraph lines.

THE CHESTER TRACTION COMPANY, Chester, Pa., capital stock $500,000, has been incorporated by E. Harvey, Geo. Potteiger and others, to construct and operate motors, cables and other machinery, and also to supply power to passenger railways.

THE AUTOMATIC ELECTRIC COUPLER AND TRAIN SIGNAL COMPANY, Portland, Ore., capital stock $100,000, has been incorporated by W. E. Wamsey, Geo. W. Simons and others for the purpose of purchasing and dealing in electric car couplers, etc.

THE MAYFIELD AND LELAND STANFORD, JR., STREET RAILWAY COMPANY, Mayfield, Cal., capital stock $10,000, has been incorporated by Alex. Pierce, Bernal Mayar, Gordon Wigle and B. L. Ryder, and the work of construction will at once be begun.

THE AMERICAN ELECTRIC COMPANY, Toledo, Ohio, capital stock $10,000, has been formed to acquire, make and sell electrical apparatus and to control and sell patents on same. O. S. Brumback, F. H. Hurd, C. F. Wall, A. A. Thatcher and S. C. Schenck are interested.

THE HARDWARE CITY TELEPHONE AND ELECTRICAL COMPANY, New Britain, Conn., capital stock $500, has been incorporated to manufacture telephones and to do general electrical work. A. F. Bromley, E. A. Loomis and C. B. Andrews, all of New Britain, are interested.

THE FLETCHER AND FLETCHER ELECTRIC COMPANY, Cleveland, Ohio, capital stock $10,000, has been formed to manufacture and deal in electrical instruments and supplies of every description. H. S. Gray, J. M. Monroe, J. R. McQuigg, G. B. Riley and John Colahan are interested.

THE INDIANA TELEPHONE AND CONSTRUCTION COMPANY, Indianapolis, Ind., maximum capital stock $300,000, has been formed to construct and operate telephone lines, machinery, etc.; also railways, etc. Charles Selden, E. W. Day and C. O. Scull, Baltimore, Md., are the promoters.

THE GILLILAND TELEPHONE COMPANY, Chicago, Ill., capital stock $1,000,000, has been formed to manufacture, sell, construct and operate telephone lines, acquire property, franchises and patent rights incident thereto. The interested parties are A. E. Crane, James Miles and H. Z. Durand.

THE WHITE-CROSBY COMPANY, maximum capital stock $250,000, has been incorporated to manufacture and sell dynamos, motors, batteries, etc.; to construct electric railways, build power plants, etc. The promoters are James G. White, E. J. D. Cross, E. J. Silkman, H. H. Harrison and H. Walbridge, Baltimore, Md.

CORTLAND, N. Y.—The Cortland and Homer Traction Company, capital stock $300,000, has been incorporated to build a 12 mile road. Herman Bergholtz, De F. Van Vleet and E. H. Bostwick, of Ithaca; Horace E. Hand and Isaac L. Post, of Scranton, Pa.; H. L. Bronson and E. A. Fish, of Cortland, N. Y., are interested.

THE RUMSEN IMPROVEMENT COMPANY, Red Bank, N. J., capital stock $100,000, has been formed to produce electricity for light and power, provide water, etc. E. Kemp, E. D. Adams, C. N. Bliss, M. C. D. Borden, H. L. Terrell, New York; W. F. Havemeyer, H. E. Owen, J. C. Hoagland, R. Hoagland, Brooklyn, N. Y., and F. W. Hope, of Red Bank, N. J., are interested.

THE CONSOLIDATED ELECTRIC IMPROVEMENT COMPANY, Camden, N. J., capital stock $100,000, has been formed to manufacture and sell all kinds of electrical appliances, dynamos, motors, fans, switches and patented specialties of every kind. The promoters are P. E. Costello, Tacony, Philadelphia, Pa.; James Franklin, 500 Chestnut street, E. W. Patten, 3926 Walnut street, and F. A. Lee, 18 South Seventh street, Philadelphia, and T. P. Curley, 552 Federal street, Camden, N. J.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, May 21, 1894.

MR. H. B. COHO, 203 Broadway, New York, who has been suffering the past two weeks with a severe attack of typhoid fever, is convalescing, and hopes to be at his office in a few days.

TRAFFIC on the trolley lines of the Atlantic Avenue Railroad Company, of Brooklyn, was suspended on Sunday, May 20, owing to a grievance of the employes in regard to a change in uniforms. The men claim that they had to buy new suits last spring and again in the fall, and that the company asks an extortionate price for the new uniforms.

THE GENERAL TERM OF THE SUPREME COURT handed down a decision yesterday affirming Justice Barrett's decision in dismissing the suit brought by Miles M. O'Brien and James G. Cannon, as receivers of the Madison Square Bank, against R. T. McDonald and the Fort Wayne Electric Light Company, to recover $150.000 due on three promissory notes.

THE ABENDROTH & ROOT MANUFACTURING COMPANY, 28 Cliff street, New York, has issued a handsome 96-page pamphlet entitled "A Few Plain Facts Concerning Water Tube Boilers." While the matter has immediate reference to the Root boiler, yet it will be found of considerable general technical interest. We know of no textbook or other publication on boilers that contains anywhere near so much information relating to the various details of tubular boilers, their construction and the theory of their operation.

Canadian Notes.

OTTAWA, Ont., May 19, 1894.

GALT, ONT.—A general meeting of the shareholders of the Galt and Preston Street Railway Company was held last week in the council chamber of the Town Hall. Thomas Todd, president, read the report of the directors for the past year, showing that $42,125 of stock had been taken up by 107 shareholders, on which a first call of 10 per cent. had been made. The contract for the electrical equipment had been let to the Westinghouse company for $15,925, for the engine and boilers to the Goldie & McCulloch company for $6,000, the building and laying of the track to J. Hartnett, of Toronto, and the contract for the cars to the Atlantic Avenue Railroad Company, Brooklyn. The total cost of the road, completed and fully equipped, is not expected to exceed $75,000.

OTTAWA, ONT.—The Canadian Pacific Railway Telegraph Company has started the construction of a line from Kingston to Ottawa, via the Rideau Canal route. There are now 15 men working for the company in the vicinity of Kingston Mills. The contract will be finished at the end of six weeks.

TORONTO, ONT.—City Engineer Keating has returned from his visit to American cities to look into the operation of electric lighting plants under civic control. The visit has impressed upon Mr. Keating the feasibility of the city taking this service in charge to the extent at least of supplying light for the streets and public buildings. At Chicago, the last point visited, he found that even with the enormous and excessive first cost of the system, the operation of the plant is a success. The city engineer is preparing a report which will certainly favor the city undertaking its own electric lighting.

English Notes.

(From our own Correspondent.)

LONDON, England, May 9, 1894.

ELECTRICITY VS. GAS.—Both electrical and gas engineers have in this country hitherto made a point of averring that the advent of the electric light would make next to no difference in the consumption of gas. An examination, however, of statistics would appear to controvert this view. There were at the end of 1893 some 700,000 10-candle 35 watt lamps connected to the mains of the statutory electric supply companies in London, and the most reliable authorities show that on an average these lamps were alight some 400 hours during the year, so that they gave the unwieldy total of 2,800 million candle hours. Reliable tests of gas burners show that one cannot expect to obtain more than two candles from one cubic foot of London gas per hour used in an average burner. From this it can be shown that had these 700,000 glow lamps been replaced by the same number of equivalent gas burners, the gas consumption of London would have been greater by some 1,400 million cubic feet than was actually the case. But this is not all. When we consider the large number of big isolated plants at work in the metropolis, we are in no danger of exaggeration if we add another 100,000 lights to the above total, making the equivalent gas consumption 1,600 millions. Now, the rate of increase between 1886 and 1891 in the sale of gas in London averaged 947 million cubic feet, the increase for 1891 being no less than 1,313 millions. In 1892, however, the very year in which electric lighting first got fairly to work, the increase in the London consumption fell to less than 35½ million cubic feet, and last year there was an actual decrease in the consumption of not less than 1,000 million cubic feet, involving a loss in revenue of £140,000. When we consider that London continues to grow, this falling off, not merely in the consumption of gas per capita, but in the aggregate, is most significant.

ELECTRIC RAILWAYS IN LONDON.—The contract for the construction of the electric tubular railway running from Waterloo Station to the city has been secured by the well known firm of Mowlem & Co., the price being £229,000, the work to be completed within 2½ years from the present time. In its eagerness to secure unusually good terms for workmen's trains, the London County Council has again succeeded in killing a suburban railway scheme. A bill giving powers to a company to run an electric or steam railway from the heart of the city to Epping Forest came before a committee of the House of Commons. The committee, at the instance of the London County Council, inserted a clause obliging the company to run workmen's trains at a penny for nine miles. The promoters of the bill now assert that unless the clause is withdrawn, the bill will be withdrawn, as it is impossible to raise capital in face of such a clause.

DEPTFORD.—The report of the London Electric Supply Corporation for the past year shows that the working of the Deptford station has resulted in a profit of £3,914, instead of the usual loss. This is stated to be mainly due to the installation in the houses of most of the consumers of an improved type of transformer.

News of the Week.

Telegraph and Telephone.

PARKERSBURG, W. VA.—A new telephone company is being organized in Parkersburg.

SALISBURY, MD.—W. B. Mitter is in the market for a complete telephone system of 60 telephones.

FLORENCE, S. C.—The Southern Telephone Company is constructing a telephone system. Franch Welch is to be the local manager.

HARTFORD, CONN.—A joint stock company has been formed to operate a new telephone system, capital stock $50,000. R. L. Andrews and Richard Schuey are the promoters.

CARROLLTON, GA.—J. L. Lovvorn, Bowden, Ga., has purchased the telephone line running from Carrollton to Graham, Ala., and is organizing a company to continue its operation.

VERNON, ALA.—The Vernon "Courier" has built a telephone line to the nearest point on the railroad from Vernon, a distance of 12 miles, and will soon purchase the necessary equipment.

KINGWOOD, W. VA.—The Kingwood and Cranberry Telephone Company will want 40 miles of No. 9 or No. 10 galvanized steel telephone wire, brackets, glass, insulators, etc. Julius K. Monroe is the president.

TAMPA, FLA.—F. A. Salomonson, J. S. McFall and W. E. Padgett, all of Tampa, Fla., have applied for the incorporation of the Tampa and Manatee River Telephone and Telegraph Company. Capital stock $2,500.

WASHINGTON, D. C.—The Agricultural Department is inviting, until June 6, proposals for the purchase of 130 miles of telegraph line extending from Titusville to Jupiter, Fla., comprising poles, wires, insulators, battery cells, tools, etc.

LINCOLN, NEB.—The Nebraska Telephone Company has accepted the terms of the City Council, and will begin the work of burying the wires in the business districts within 30 days. A solid fireproof building will be erected and equipped with a new switchboard.

LOCKPORT, N. Y.—City Superintendent of Fire Alarm Edward Griffin is trying to interest the Business Men's Association in the proposition of the Harrison Telephone and International Electrical Company, of New York, to put a telephone system in Lockport. Two hundred subscribers are needed.

Electric Light and Power.

CUSTER, S. D.—Residents talk of putting in an electric light plant.

TOLEDO, OHIO.—The Telephone Exchange has been completely destroyed by fire,

WILKESBARRE, PA.—The electrical works of J. G. Seitzinger have been burned.

CHESTERVILLE, S. D.—A company is being organized to put in an electric light plant.

SOUTHERN PINES, N. C.—S. M. Morfit is in the market for a lighting outfit for a hotel.

ROCHESTER, MINN.—The street lighting committee will purchase additional arc lights.

OSHKOSH, WIS.—The Board of Public Works is negotiating for electric lighting for the city.

GRAND RAPIDS, MINN.—The village authorities of Grand Rapids are taking steps towards electric street lighting.

ELKHART, IND.—The Home Electric Company has been given the contract to put in 75 arc lights for street lighting.

STILLWATER, MINN.—The plant of the Electric Light Company is buried under a mountain of sand. Loss $25,000.

CARDINGTON, OHIO.—A bill is before the Ohio Legislature authorizing the city to issue $25,000 in bonds to build an electric road.

BELVIDERE, N. J.—Permission has been given to the Warren Wood Working Company to introduce electric lights into the town.

MOUNT GILEAD, OHIO.—E. F. Gwynn and L. L. Denison, of Delaware, Ohio, have been granted a franchise for an electric light plant.

EVART, MICH.—Bids for the proposed electric light plant will be received till June 2, at 7:30 P. M., by C. E. Bell, chairman of the committee.

ROME, N. Y.—Architect Jacob Agne may be addressed concerning electric motor and lighting apparatus for the new county almshouse.

VAILSBURG, N. J.—The Newark Electric Light Company has made a proposition to furnish electric light to the borough, but action was deferred.

TOPEKA, KAN.—Architect J. W. Perkins, 720 Kansas avenue, may be communicated with relative to electric lighting apparatus for the Santa Fe Hospital.

CHESANING, MICH.—Residents are considering water works and an electric light plant. G. L. Chapman, E. T. Long and Bert Morhouse are the committee.

LONDON, CANADA.—Address A. Ormsby Graydon, city engineer, concerning contract for lighting that city for a term of one, three, five or eight years.

CHICAGO, ILL.—The Western Electric Company, of 242 South Jefferson street, will build an addition to its factory from plans of Treat & Folz, of 58 Wabash avenue.

BUCKSPORT, ME.—The Bucksport Electric Light and Power Company was formed May 14 with a capital stock of $10,000. It will be in need of supplies immediately.

BELLEVILLE, ILL.—City Clerk W. F. Puederer, in his report to the council, recommends that the city build its own electric light works. The plant can be put in for $41,000.

BERLIN, PA.—The Berlin Town Council has made a contract for lighting the streets of the city by oil lamps, which would seem to do away with the proposed electric street lighting.

SAN ANGELO, TEX.—The San Angelo Electric Light Company will increase its plant by adding an 80-h. p. compound engine with boiler, pump, heater and extractor and all connections.

MACON, GA.—The Macon Gas Light and Water Company has been placed in the hands of a temporary receiver. A hearing is to be had May 15 relative to making the receivership permanent.

LAKE CITY, FLA.—The Lake City Ice, Light and Water Company will erect an electric light plant with 30 arc, 1,200-candle power, and 300 16-candle power lights. Wm. R. Bush is manager.

LANCASTER, WIS.—Meyer & Shawalter are asking for an exclusive franchise for 15 years to operate an electric light plant, and they will be in the market for the necessary equipment when the matter of a franchise is settled.

SOUTH MILWAUKEE, WIS.—The Electric Light Board and W. M. William, owner of the plant, are at odds as regards price. The village president states that they cannot afford to take a step backward, even if the board had to take charge of the plant.

ROCHESTER, N. Y.—The petition of the Central Light and Power Company for right to construct an underground conduit on Main street is being opposed by the Rochester Gas and Electric Company, and the executive board is trying to compromise matters.

HEMPSTEAD, L. I., N. Y.—The Ball Electric Light Company, which succeeded the first electric light company, finds that business in Hempstead is unprofitable, and it has given notice that after June 10 all lamps and fixtures will be removed from the stores.

CAIRO, EGYPT.—Address Frederick C. Penfield, United States Agent and Consul General, regarding bids invited by the Khedive for the proposed concession for constructing and operating a system of electric tramways in Cairo and its environs. The bids are to be opened August 1.

NIAGARA FALLS, N. Y.—Secretary Wm. B. Rankine, of the Cataract Construction Company, has authorized John J. McIntyre, who is interested in property in Grand Island, to secure right of way across the island and to erect poles and string wires for the purpose of transmitting power.

HARLEM, ILL.—The Village Council has appointed W. F. Frechs, of Oak Park, to make plans for the village electric light plant, and the board will call for bids at an early date. They will require a 100-h. p. boiler and a 100-h. p. engine for the power house. The lighting will be done by 300 incandescent lights.

BROOKLYN, N. Y.—The gas and lamp committee reported in the matter of the application of the Kings County Electric Light Company, Noah Cocheu, president, for a franchise, that they were in favor of granting same on certain conditions, but on motion of Alderman Guilfoyle the matter has been laid over for a week.

MARTIN'S FERRY, OHIO.—It is stated that the injunction gotten out against the proposed civic electric light plant was procured by opponents on the ground that the vote was taken 17 days before the time advertised by law, whereas 30 days are required. There seems to be no doubt that the scheme will be pushed to completion.

JACKSON, TENN.—S. C. Lancaster, city engineer, may be addressed regarding bids to be opened June 1 for furnishing the city for five years with the privilege of 50 300-candle power arc lamps for street illumination. The city government will grant a franchise for the exclusive operation of an incandescent plant for domestic use for five years.

LEADVILLE, COL.—An electric lighting company has been formed by the prominent business men of Leadville for the purpose of furnishing the city with light and power. The company is incorporated under the name of "The Citizens' Electric Light Company," with officers as follows: J. M. Maxwell, persident; H. H. Tomkins, vice president; D. La Salle, secretary and treasurer, and Geo. P. Brown, general manager, and will be in competition with the Leadville Electric Light and Power Company, who have enjoyed the exclusive privilege of lighting the city for about 10 years. The Citizens' Electric Light Company has amply proven its staying qualities in an injunction suit brought against it by the old company, by whom a temporary injunction was obtained on the ground that it was impossible for the new company to operate a plant in the same town without great and irreparable damage to the plaintiff's wire, machines and apparatus. The case was tried before Judge Dickson and the injunction denied. Messrs. Shepard and Searing, consulting mechanical and electrical engineers, have been placed in charge of the design and installation of the complete plant, and are expected to make it one of the model plants of the State. The station will have an ultimate capacity of 3,000 incandescents and 150 arcs.

The Electric Railway.

MONTREAL, CANADA.—The Montreal Street Railway Company is to erect a $14,000 building for motor cars.

JAMAICA, L. I., N. Y.—On May 21 will be heard the petition for another electric railway from Jamaica to Rockaway.

WESTERLY, R. I.—The Town Council has granted a franchise, as asked for, to the Pawtucket Valley Street Railway Company.

WASHINGTON GROVE, MD.—Thomas E. Brooke and others are interested in the construction of an electric railway to Sandy Springs.

JACKSONVILLE, FLA.—L. R. Benjamin will soon begin work on a dummy line from Jacksonville to Gilea, to be changed later to electric power.

WESTERLY, R. I.—The proposed electric railway from Westerly to Watch Hill is now assured, and E. P. Shaw states that that road will soon be in operation.

NASHVILLE, TENN.—The Overland Electric Railway was sold by order of the court on May 11, subject to $100,000 mortgage bonds. R. W. Hunter bought the road, paying $10,433.

STILLWATER, MINN.—The freeholders who bought the street railway will organize a company with a capital stock of $75,000. The line will be extended and additional stock purchased.

TROY, N. Y.—The Troy and New England Railway Company, which proposes to build an electric railway through the town of Sand Lake, will be given a hearing at Averill Park on May 31.

NIAGARA FALLS, N. Y.—J. W. Hoffmann and Chas. A. Simms, of Philadelphia, Pa., have been in Niagara Falls looking over the ground for the proposed double track electric railway from here to Buffalo.

RANDALLSTOWN, MD.—The Randallstown, Granite and Harrisonville Rapid Transit Company has applied to the Baltimore County Commissioners for permission to extend its electric line along certain roads.

JASPER, N. Y.—The proposed electric railway between Jasper and Geneseo seems to be an assured fact in the near future. The names of the promoters have not yet been published, but details will soon appear.

CORTLAND, N. Y.—The Cortland and Homer Electric Railway Company, which was granted permission to change its motive power from horse to electricity, states that it will have the road completed about August 1.

DALLAS, TEX.—The Dallas and Fort Worth Rapid Transit Terminal Railway Company and the West Dallas Railway are reported to have been purchased by Henry C. Scott, president of the St. Louis Trust Company. Improvements are to be made and the motive power may be changed to steam.

BELLEVILLE, ILL.—The Belleville Electric Railway Company has closed a deal with the East St. Louis Electric Railway Com-

pany for terminal privileges in East St. Louis, and it will construct an electric line between these two towns at once.

WEST UNION, OHIO.—The County Commissioners have been petitioned by Frank E. Holiday, of Boston, Mass., for a franchise for an electric railway from Manchester, by way of Bentonville, to West Union. Right of way has been given by residents.

BALTIMORE, MD.—Architect Henry Brauns has completed plans for the new power house of the City and Suburban Railway Company, and contracts will soon be awarded. The building will cost $150,000, and the electric equipment will bring the cost to $500,000.

ST. LOUIS, MO.—The Bellefontaine Electric Road will build a $5,000 addition to its plant at 20th and Bissell streets. The increase in power is intended for the Herbert street division, which is to be extended to Sportsmen's Park. The office of the company is at 4238 North Twentieth street.

SCRANTON, PA.—Mayor W. L. Connell has written to General Manager Archer, of the Traction company, stating that as the company had not complied with the terms of franchises granted to it for certain streets, and the time for same having expired, the franchises are null and void.

PHILADELPHIA, PA.—A franchise has been granted at Harrisburg to the Diamond Street Railway Company to operate by any other power than steam a street railway on Diamond and other streets in Philadelphia, Pa. The incorporators of the company are Henry C. Moore, David C. Golden, Thomas B. Foote and Joseph C. Lugar.

CAMDEN, N. J.—Articles of incorporation for the Midland Improvement Company have been filed in the office of the county clerk. The capital stock of the company is $100,000, and they propose to build, equip, purchase and operate electric street railways. The incorporators are C. Henry Allen, of Moorestown; Ephraim K. Allen, of Philadelphia, Pa., and Henry L. Washburn, of New York.

PHILADELPHIA, PA.—Charters have been issued at Harrisburg for the following companies to operate in Philadelphia, all having the same incorporators: The Citizens' North End Street Railway Company, the Citizens' Clearfield and Cambria Street Railway Company, the Brown and Parrish Street Railway Company, and the Citizens' East End Railway Company, all to be operated by any power except locomotives. Jeremiah J. Sullivan, Robert C. Brewster, and George S. Gandy are interested.

JAMAICA, L. I., N. Y.—The Long Island Electric Railway Company, which is stated to be the local name of the Pennsylvania Traction Company, is applying for a franchise for an electric road from Brooklyn to Patchogue, and the highway commissioners have agreed to grant the franchise, subject to certain stipulations to be detailed hereafter. Jere Wernberg, of Brooklyn, is counsel for the company, and the officers are A. R. Hart, of Brooklyn, president; C. H. Mullin, of Mount Holly Springs, Pa.; Clarence Wolf and J. C. Von Arx, of Philadelphia, Pa.

Trade and Industrial Notes.

THE CARPENTER ENAMEL RHEOSTAT COMPANY, Hoboken, N. J., has made another notable reduction in the price of rheostats for motors from 1-12 to 2 h. p.

THE GENERAL ELECTRIC LAUNCH COMPANY has just sold an electric launch to Cornelius Vanderbilt, for use at Newport. It will be equipped with the Consolidated Electric Storage Company's batteries.

THE AUTOMATIC ELECTRIC SPECIALTY COMPANY, 136 Liberty street, New York, which has the agency for the sale of the Hoggson electric date and time stamp, is daily appointing subagents throughout the country.

MR. M. H. JOHNSON, formerly of Milwaukee, has opened an office as consulting electrician in the Martin Building, Utica, N. Y. Mr. Johnson has had varied experience in this line of work, and will no doubt meet with well merited success.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is placing upon the market a complete magneto telephone system for private lines and office and factory exchanges. The principal feature of the system is in its Acme magneto telephone.

MR. CHARLES F. FOSTER, late mechanical engineer of the World's Columbian Exposition, has opened an office at 1411-1412 Manhattan Building, Chicago, Ill. Mr. Foster intends to carry on a general engineering business, for which his past experience has well equipped him.

THE MILLER ELECTRICAL WORKS, of North Fourth street, Philadelphia, though very recently established, are very busy repairing armatures and commutators with the Miller tempered copper, which apparently is an innovation in tempered copper. It is claimed that there is practically no wear to this material.

THE INTERIOR CONDUIT AND INSULATION COMPANY, 44 Board street, New York, has issued a handsome 56-page catalogue embodying descriptions of all Lundell machines up to date, including fan outfits. The binding, paper and presswork are of the highest quality, and it is only necessary to say that the admirable cuts are by Bartlett.

THE ELECTRIC SELECTOR AND SIGNAL COMPANY, 45 Broadway, New York, has completed a new type of electric light and power controller, which is much simpler and cheaper than that formerly manufactured by it. Notable improvements have been introduced in the mechanism under new patents, so that the controller is now practically perfect.

THE AUTOMATIC SWITCH COMPANY, 703 Equitable Building, Baltimore, Md., has received some flattering testimonials in regard to its automatic motor starters. The Michigan Electric Company, of Detroit, states that in one case its use reduced the cost of running an electric elevator from $35 to $7.50 per month, and the Boston Electric Company speaks of its good qualities in strong terms.

I. P. FRINK, 551 Pearl street, New York, is making a reflector for arc lamps suitable for lighting very large spaces, similar to a parabolic reflector, but larger, and lined with silverplated corrugated glass cut in small pieces to break up the light and diffuse it thoroughly. Mr. Frink has recently installed a large number of these reflectors in Buffalo Bill's Wild West Show, South Brooklyn.

EDWIN HARRINGTON, SON & CO., Incorporated, 1527 Pennsylvania avenue, Philadelphia, have issued a pamphlet descriptive of apparatus for the economical handling of heavy central and power station machinery, consisting of differential hoists, overhead tramways, travelling cranes, travellers, turn-tables, etc. Station managers and others will find it to their interest to look up these standard equipments.

THE D'ESTE & SEELEY COMPANY, of Boston, reports a largely increased sale of the Curtis engineering specialties, being 20 per cent. more in 1893 than in any previous year; also that its sales are steadily increasing this year over last. Among recent-sales it reports a third order from the American Sugar Refining Company, of New Orleans, for 24 Curtis balanced steam traps, with condensing capacity for 30,000 feet of pipe each; also a large combined reducing and relief valve for the Rock Cliff Water Company, of New York.

HILL BROS. & CO. and A. C. Sneed & Co., of Waco, Tex., the firms consisting of B. H. Hill, N. S. Hill and A. C. Sneed, on May 1 dissolved by mutual consent. B. H. Hill and N. S. Hill assume all liabilities of the firm of Hill Bros. & Co., and all amounts due said firm are payable to them. They will continue in business at the former stand of Hill Bros. & Co., No. 325 Austin avenue, under the firm name of Hill Bros. A. C. Sneed assumes all liabilities of the firm of A. C. Sneed & Co., and all amounts due said firm are payable to him. He will continue in business at the former stand of A. C. Sneed & Co., No 403 Austin avenue, under the firm name of A. C. Sneed & Co.

THE GENERAL ELECTRIC COMPANY reports the following orders for railway apparatus taken during the past week from the New York office alone: Brooklyn, Queens County and Suburban Company, 450 motors; Bridgeport (Conn.) Traction Company, 60 motors and generators; Danbury (Conn.) Street Railway Company, 20 motors; New Haven (Conn.) Street Railway Company, 20 motors and generators; Hart (Conn.) Street Railway Company, 8 motors; Allegheny Traction Company, Pittsburgh, Pa., 30 motors and generators; Jacob Rich, San Jose, Cal., 2 equipments and generators; W. B. Ferguson, Boston, generator; Franklin, Pa., 6 motors; Electric Traction Company and People's Traction Company, Philadelphia, Pa., large marble switchboards.

J. GRANT HIGH & CO., of Philadelphia, have recently gone into the manufacture of switchboards of all sizes. This company has just shipped two fine boards, fitted up with quick break switches, to the Ringing Rock Electric Railroad Company, at Pottstown, Pa., and is now very busy making a very elaborate switchboard containing 185 feet of Italian marble, and which will have 34 circuits. The particular feature of this board is that the back will have a closet with bevel French plate glass doors, thus showing all the back connections. The fuse connections are so arranged that on the failure of the first fuse, the second one is automatically thrown in. Mr. Eyanson, treasurer of the firm, is bringing out a new quick break switch, which he expects to put on the market very shortly.

MR. C. J. FIELD and the Field Engineering Company, with which company the former has been identified since its organization as president and chief engineer, are making a number of changes in their business. They have been identified as engineers and contractors with some of the largest electric railway and central station construction work, and have also been associated with several of the large syndicates as their engineers. Mr. Field and Messrs. Bourne and Cook, who have been connected with him in the management of the company, have determined, owing to the large demand for such services, to devote their time entirely to consulting and supervising engineering work, and to discontinue their interests in construction work. They are, therefore, arranging to gradually wind up the business of the Field Engineering Company, and to continue the engineering and consulting business under the name of C. J. Field, consulting engineer. They will continue to do business in the same offices and location in the Central Building, New York, where they have been located for the past four years. They are at present acting in this capacity for several large roads and banking interests. The wide experience of Mr. Field, who has largely outlined by his work in the past the present practice in the design and construction of central and power stations, will give him an enviable advantage in the field to which he will hereafter confine himself.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, reports the following sales: Edison Illuminating Company, Monmouth, Ill., 625-h. p. live steam purifier; Columbus (Ohio) Electric Light and Power Company, 2,000-h. p. exhaust steam heater; Delaware (Ohio) Electric Light and Power Company, 500-h. p. live

steam purifier; Bay City (Mich.) Union Railway Company, 400-h. p. live steam purifier, and 400-h. p. exhaust steam heater; Oconomowoc (Wis.) Electric Light Company, 200-h. p. exhaust steam heater; Freeport (Ill.) Gas Light and Coke Company, 300-h. p. exhaust steam heater; Citizens' Street Railway Company, Muncie, Ind., 350-h. p. exhaust steam heater; Heat, Light and Power Company, Muncie, Ind., 300-h. p. exhaust steam heater; Muscatine (Iowa) Electric Railway Company, 400-h. p. exhaust steam heater; Columbus (Ohio) Street Railway Company, 1,000-h. p. live steam purifier; Omaha (Neb.) Gas Manufacturing Company, 200-h. p. live steam purifier; Elmira (N. Y.) Illuminating Company, 1,000-h. p. live steam purifier; Citizens' Gas and Electric Company, Jacksonville, Fla., 80-h. p. live steam purifier; East River Gas Company, Long Island City, N. Y., 625-h. p. live steam purifier; Edison Electric Light Company, Dayton, Ohio, 750 h. p. live steam purifier; Calumet Electric Railway Company, Burnside Crossing, Ill., 1,000-h. p. live steam purifier; Shreveport (La.) Gas, Electric Light and Power Company, 300-h. p. exhaust steam heater; Waco (Tex.) Electric Railway and Light Company, 800-h. p. exhaust steam heater; People's Traction Company, Philadelphia, Pa., two 3,000-h. p. exhaust steam heaters; Public Lighting Commission, Detroit, Mich., seven 3,000-h. p. live steam purifiers.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY is now making a special type of battery for the General Electric Launch Company—strong, durable and of good capacity. Address, Edison Building, New York, or Drexel Building, Philadelphia.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MANUFACTURING COMPANY, 2140 DeKalb St., St. Louis, Mo.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MAY 8, 1894.

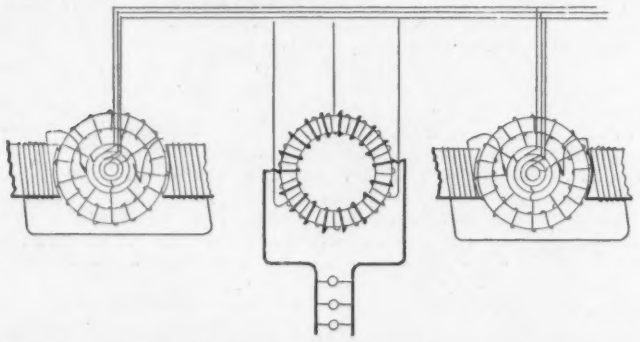
(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

519,328. CONTACTING DEVICE FOR ELECTRIC RAILWAYS; D. F. Graham, Springfield, Ohio, and W. P. Allen, Chicago, Ill. Application filed Oct. 25, 1893. The combination with conductors of hinged bars carrying grooved wheels, a hollow standard supporting the bars, and insulated conductors extending from the hinged bars through the standard.

519,330. GALVANIC BATTERY; C. W. A. Hertel, Berlin, Germany. Application filed July 14, 1893. The combination of a containing vessel, carbon electrode, porous carbon cylinder, zinc electrode within the same, and a glass rod passing through the stem of the electrode and resting upon the top of the cylinder.

519,334. CARBON HOLDER FOR ARC LAMPS; E. Lavens, Brooklyn, N. Y. Application filed Sept. 30, 1893. The combination of a base piece, two arms pivotally connected to each other, and a cam or wedge movable between the arms so as to move one of them relatively to the other.

519,335. REACTIVE COIL; H. Lemp, Lynn, Mass. Application filed Nov. 21, 1889. This comprises a sectional conductor and a conductor on locally closed circuit, and adjustable in inductive relation to the first, switch contacts and connections to the terminals of the sectional conductors for changing the sections from series to series-multiple or to multiple, and vice versa.



NO. 519,376.—ALTERNATING CURRENT TRANSFORMER.

519,336. ELECTRIC WELDING MACHINE; H. Lemp and C. G. Anderson, Lynn, Mass. Application filed May 26, 1891. This comprises a movable work holder, an adjustable stop connected therewith, a contact in the path thereof, and a cut-off magnet, the circuit of which is connected to the contact.

519,338. ELECTRIC SWITCH; J. F. McElroy, Albany, N. Y. Application filed Aug. 2, 1893. This comprises a cylinder having cored passageways, a series of metallic plugs placed within the ways, the plugs being substantially flush with the surface of the cylinder and insulated from the periphery thereof.

519,376. ALTERNATING CURRENT TRANSFORMER; C. S. Bradley, Avon, N. Y. Application filed March 15, 1892. This comprises a polyphase alternating current circuit of a transformer having a closed coil winding connected with the several wires of the polyphase circuit, the transformer being provided with a closed coil secondary winding, tapped at two opposite points for connection with the distribution circuit. (See illustration.)

519,377. GENERATING AND UTILIZING ELECTRIC CURRENTS OF HIGH POTENTIAL; C. S. Bradley, Avon, N. Y. Application filed Nov. 10, 1892. A generator mounted upon supports insulated in oil and provided with an insulated platform upon which an attendant must mount to gain access to the machine.

519,380. CONDUIT ELECTRIC RAILWAY; J. F. Cook, Mansfield, Pa. Application filed Feb. 5, 1894. This consists of sections of earthenware or other non-conducting hollow boxes placed end to end and provided with an opening at the side and a top or shield somewhat wider than the bottom projecting out over the opening, the conducting wire being supported at intervals by cross wires insulated from and attached to the inside faces of the sides.

519,382. SAFETY WATER COLUMN; H. Engel, Cleveland, Ohio. Application filed Feb. 9, 1894. This comprises a vertically moving rod, and a push rod through the column, and a shoe on the inner end of the rod, and a part with two separated contact points to bear against the shoe and actuated by the float rod.

519,446. TROLLEY WIRE HANGER; A. B. Crounse and A. Rutledge, Passaic, N. J. Application filed July 21, 1893. A trolley hanger provided with an insulating cup containing a liquid insulating medium, in combination with an adjustable cup or cover.

519,482. ELECTRIC ACCUMULATOR OR SECONDARY BATTERY; A. J. Smith, London, England. Application filed July 20, 1893. This consists in repeatedly coating a metal sheet or plate with a metallic oxide and driving or kneading the oxide into the metal by means of pointed rods or needles.

519,497. ELECTRIC FIRE ALARM TRANSMITTER; A. Dunish, Ravenna, Ohio. Application filed Jan. 16, 1894. This comprises movable and stationary binding posts, a cord easily separable by heat, a rod connecting the cord with the movable binding post and retaining it from contact with the other binding post.

519,519. TROLLEY WIRE CROSSING; E. H. Allen, Cramer's Hill, N. J. Application filed Feb. 2, 1894. The combination of a central insulating block, projecting arms and plates whereby the arms are secured to the insulating block.

519,602. STORAGE BATTERY PLATE; C. P. Elieson, London, England. Application filed Oct. 26, 1893. A plate built up of parallel layers of corrugated and perforated metal, the corrugations of one layer being at an angle to those of the adjacent layer.

519,621. TROLLEY WIRE HANGER; C. F. Strasburg, Lincoln, Neb. Application filed Aug. 31, 1893. A trolley wire clamp having a rectangular groove for the trolley wire, substantially coextensive with the body portion of the clamp and continuous.

519,634. ELECTRICAL TEMPERATURE ANNUNCIATOR; E. Kloss, Stettin, Germany. Application filed Dec. 22, 1893. This comprises a casing closed by a diaphragm, a projection fixed to the diaphragm and adapted to close an electric circuit, and an adjustable screw arranged parallel to the diaphragm, the screw forming a cone at its end adapted to limit the movements of the projection.

519,662. ELECTROMAGNETIC TOOLS; C. F. Carpenter, Louisville, Ky. Application filed June 20, 1891. This comprises end magnets separated from each other, and a central magnet carrying an alternating current having a loose armature coil reciprocating between the inner extremities of the cores of the end magnets, and a bit operating hammer rod carried by the armature core.

519,674. ELECTRICAL PROPULSION OF RAILWAY CARS; J. J. Heilmann, Belfort, France. Application filed Dec. 18, 1890. An electrically propelled train consisting of a plurality of vehicles, the ends of which are provided with wings adapted to open outwardly on vertical axes, and when shut to cover the space between the vehicles and preserve the skin continuity of the train.

519,686. METHOD OF OPERATING ELECTRIC MOTORS; J. S. Bancroft, Philadelphia, Pa. Application filed Dec. 15, 1892. This comprises two or more motors with current for the fields, a reversing switch for the armature circuit of each motor, a rheostat controlling the potential of the armature current and means for interlocking the actuating parts of the reversing switches with the actuating part of the rheostat.

Copies of the specifications and drawings complete of any patent mentioned in this record---or of any other patent issued since 1886---can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., 253 Broadway, New York.